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A LONG PLATE-GIRDER BRIDGE AND GRADE AND ALINEMENT CHANGES ON THE LEHIGH VALLEY R. R., AT TOWANDA, PA.

By PHILIP H. DE WITT,* M. Am. Soc. C. E.

Among the important works of improvement now going on along the Lehigh Valley R. R. are changes in alinement and grades and a new bridge across the Susquehanna River at that point, near Towanda, Pa.

The combination of grades and curvature on the present line between Towanda and Wysox makes this the limiting point for train loads on the engine run between Coxton and Sayre for both east and west-bound trains. The profiles on Fig. 1 show the conditions existing here before and after the changes, actual and equivalent grades being given in each case. The next limiting point on this division is at Vosburg Tunnel, where the conditions are such that there is but little opportunity for lowering grades. It was therefore decided that if the grades and alinement between Towanda and Wysox were reduced to such an extent as to make Vosburg the limiting point for the engine run, the improvements would be ample.

Computations of the reduction in train mileage due to heavier trains that can be hauled over the revised line, including heavier motive power over the new bridge, further showed a capitalized annual saving in excess of the entire cost of the improvement, including the cost of the new bridge, and this justified the outlay. Numerous lines were projected and estimated on, notably several crossing the river into Towanda, with the idea of a more convenient location for a passenger station for the town; but the excessive cost of the crossing and of right-of-way caused the abandonment of the scheme and the adoption of the line which is now being built. Two very objectionable grade crossings are also eliminated and a new station provided for Towanda.

SUSQUEHANNA RIVER CROSSING.—A general view of the completed masonry for the Susquehanna River crossing is shown above. The old masonry of the present bridge was built in 1865, the piers being sunk in the deep water of a dam located just below it. When the dam was subsequently carried out in 1874, it left these cribs exposed to the elements.

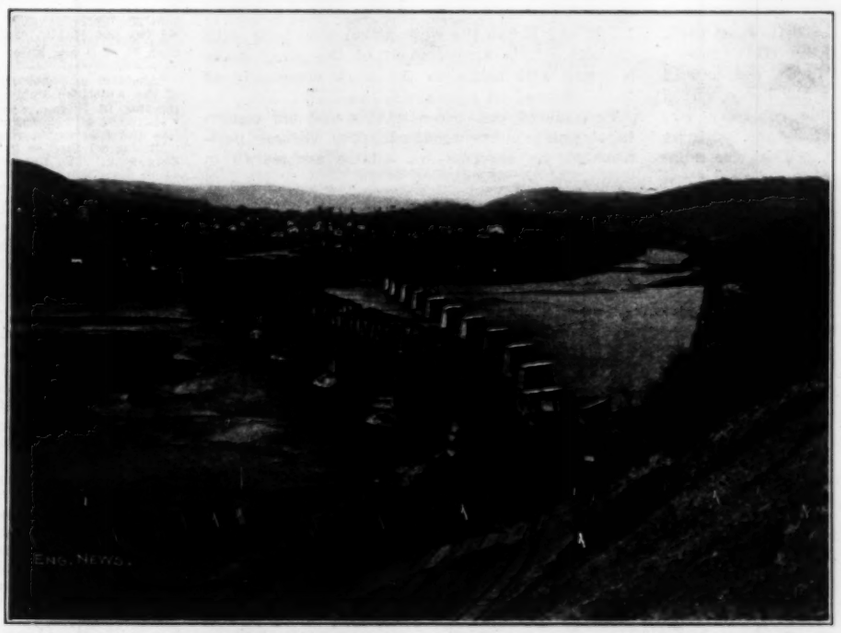
The new bridge is built with 3° 30′ curves at each end in place of 7° 30′ curves in the old bridge, which limited the train tonnage. The piers of the new bridge are spaced closer than in the old bridge, so as to allow deck-plate girders to be used in place of truss spans. The new bridge is being built with absolutely no interference with the operation of the road, which would not have been the case if the old structure had been remodeled—an important condition on a busy line.

The new bridge will consist of 14 spans of deck-plate girders, all of which are 129 ft. 6 ins. long over all and 10 ft. 1½ ins. deep, except for the east span, where the spacings are odd owing to the different skew of the east abutment. The total length of the crossing is 1,801 ft. from abutment to abutment. The distance from base of rail to top of masonry is 13 ft., and the girders weigh approximately 65 tons apiece.

The girders are now being erected by the Phoenix Bridge Co., of Phoenixville, Pa., which has the contract for the steel work. They will be erected by a cantilever traveler without the use of falsework owing to the risk from high water and ice at this season of the year.

MASONRY SUBSTRUCTURE.—The masonry consists of 13 piers and 2 abutments, all of concrete, resting on piles. A general view of the completed masonry is shown above. The east abutment is faced against the north wing of the old east abutment. The 13 piers are all of the same general design, the leading dimensions being shown in Fig. 3.

The foundations were excavated by hand, inside clay puddled cofferdams, to the specified depth below the river bed, after which the piles were driven in each foundation, and cut-off level 2 ft. above the bottom of the foundation. Oak piles were used throughout, and were driven with drop hammers. At first a water jet was used in driving; but it was found that the nature of the material, which consists of coarse gravel and sand, was not suited to the use of the jet and it was discontinued. Piles could be driven just as deep and more rapidly without the jet than with it, and with less disturbance to the material in the bottom of the foundation. After the piles were sawed off, the foundation pumps were stopped and the foundation concrete was then deposited through steel chutes of varying lengths. The pumping was unusually heavy in the pier foundations, as many as four 6-in. and 8-in. centrifugal pumps being used on a foundation owing to the large amount of water coming up through the bottom.



VIEW OF OLD BRIDGE AND PIERS FOR NEW BRIDGE ACROSS SUSQUEHANNA RIVER, AT TOWANDA, PA.

The west abutment is of reinforced concrete construction. As seen by Fig. 3, the back of the abutment is pocketed and reinforced with ¾-in. steel rods. The high price of lumber and labor required to build the more complicated form necessary for this abutment probably counterbalanced the saving in concrete due to the pockets. This abutment also rests on piles and contains about 2,000 cu. yds. of concrete.

River gravel was used throughout in the concrete. The concrete was mixed in Ransome mixers in the following proportions: Piers, including foundations, 1:2:4; abutment foundations, 1:3:6; abutment neat work, 1:2½:5, with the exception of the backwalls and coping, which were 1:2:4.

The contract for the masonry was awarded on April 4, 1906, preliminary and shore work was started April 15, but owing to high water the river work was not started until July 9. Notwithstanding these delays, the work was completed Oct. 29, 1906, which was over a month before the expiration of the date for completion of the contract. In other words, the 11 river piers were completed in less than four months.

*Phillipsburg, N. J.

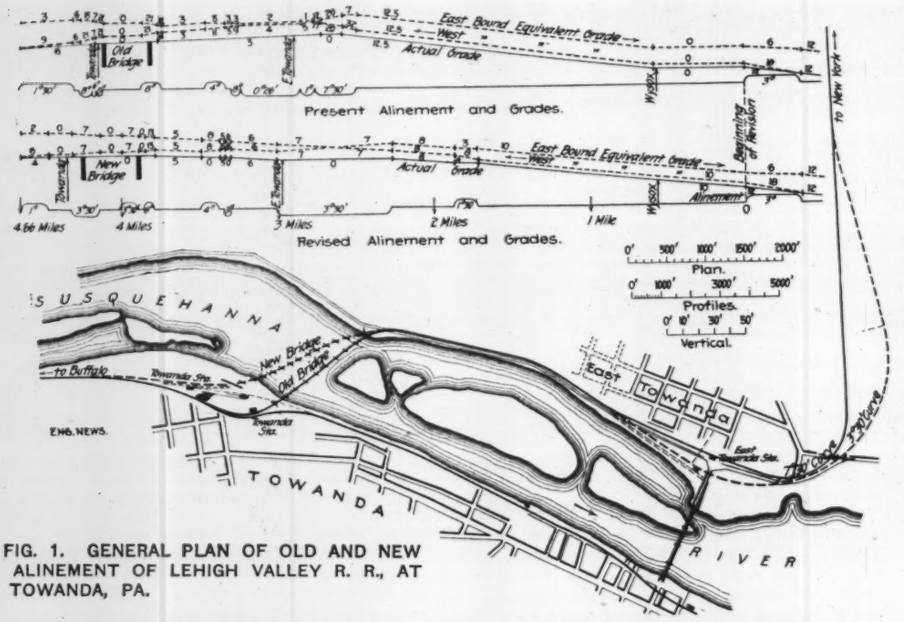


FIG. 1. GENERAL PLAN OF OLD AND NEW ALINEMENT OF LEHIGH VALLEY R. R., AT TOWANDA, PA.

In order to complete the work within the required time, a large plant was required to take advantage of the short working season of low water, and all preliminary work possible was done so that the plant would be ready when the river was favorable for foundation work. The general layout of the plant is shown in Fig. 4. Three cableways supplemented by derricks were employed. The main cableways consisted of a double Lidgerwood plant, of 1,000-ft. span each, supported on the shore ends by 80-ft. towers containing the machinery and in the center with a 75-ft. A-frame tail tower on pile bents, guyed in four directions. This double cableway was designed for a working load of 3 tons, with an occasional overload of 7 tons, which was sufficient to pick up and set mixers, pile-drivers and hoisting engines, in addition to regularly hauling concrete and other materials. A track was located under each cable at the shore towers so that machinery could be handled directly from railway cars.

A smaller cableway of 500 ft. span was used to build the east abutment and piers 1 and 2 (on the east curve), and the west abutment and piers 11, 12 and 13 (on the west curve) were built with derricks. This arrangement of the plant made it possible to carry on the work constantly at four independent points.

Two piledrivers, three mixers and six centrifugal pumps were required. The various positions of the derricks and mixers are shown in Fig. 4. The plant in the river was b[illegible] up sufficiently high and guyed to provide [illegible] an ordinary summer rise in the river.

The entire work proved to be well a[illegible] for cableway construction, and it is [illegible]btful whether any different equipment wo[illegible] have done the work within the time without [illegible]der-able additional expense. The double span [illegible]ger-wood cableway, attached to the A-fr[illegible] tall tower, is believed to be a novel arra[illegible]ment. Photographs of the shore towers and [illegible]e A-frame are shown in Figs. 5 and 6. The [illegible] tower was guyed rigidly in four directions in [illegible]er to prevent the vibration of one side of t[illegible] cable being transmitted to the other and in[illegible]fering with the independent operation of t[illegible] two plants.

The masonry and substructure work [illegible] the bridge was done under contract by S. B. [illegible]utch-ler & Co., of Phillipsburg, N. J., of wh[illegible] firm the writer is a member. The improvem[illegible]ts are being carried out under the direction of Walter G. Berg, M. Am. Soc. C. E., Chief Engin[illegible] F. E. Schall, M. Am. Soc. C. E., Bridge Engine[illegible], and E. H Shipman, Assistant Engineer of the Lehigh Valley R. R.

THE USE OF LACTOSE BILE MEDIA IN W[illegible]ER ANALYSIS.*

By DANIEL D. JACKSON.†

The determination of intestinal bacteria as represented by Bacillus coli gives a most valuable index of the quality of a water from a sanitary standpoint. Unfortunately the presumptive test with Smith solution, owing to the interference of other growths of bacteria, has often proved to be misleading, especially in badly polluted waters.

In a paper previously published, entitled "A New Solution for the Presumptive Test for Bacillus Coli,"‡ the author has described numerous experiments on the selective inhibiting effect upon the growth of bacteria by the various salts and their constituents found in the bile. By the use of bile media most species of bacteria other than B. coli are killed or restrained, thus allowing the

*Abstract of paper read before the Laboratory Section of the American Public Health Association at its annual meeting in Mexico, Dec. 3, 1907.

†Director of Laboratories, Department of Water Supply, Gas and Electricity, New York City.

‡Biological Studies by the Pupils of William Thompson Sedgewick. The University of Chicago Press, June, 1907.

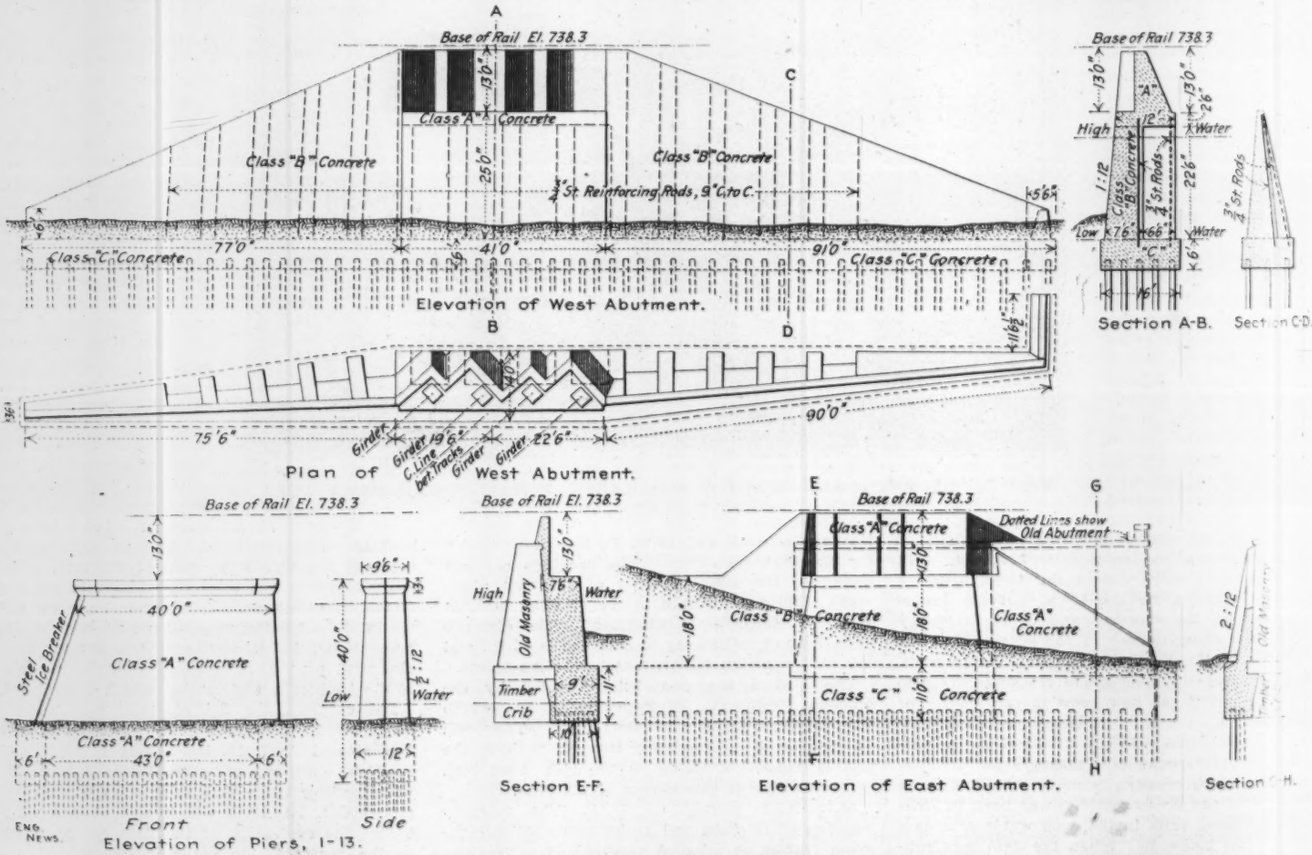


FIG. 3. DETAILS OF CONCRETE PIERS AND ABUTMENTS FOR NEW BRIDGE OF LEHIGH VALLEY R. R., TOWANDA, PA.

free action of the intestinal germs. The tests showed that it is the cholic acid radical of the bile which is the effective agent. This conclusion is important in that it admits of the use of sodium glycocholate as an inhibiting agent, in ox bile, which is the material most available, nearly all of the bile salt present is in the form of glycocholate.

The experiments also showed that good results were obtained only when an amount of bile salt was used equal to that present in undiluted ox bile, but that further concentration was unnecessary. Liquid ox bile, filtered after sterilization, contains about 110 grams of solid matter per liter, of which about 90 grams consists of bile salts. This is an amount far in excess of that previously employed as a restraining agent, but a lesser amount gives less efficient results. The liquid also contains albuminous matter equal in food value to the meat extract employed in the usual media.

An undiluted bile solution, sterilized when freshly drawn, may be kept in stock until ready for use. It is then decanted or filtered and 1% of lactose previously dissolved in a small amount of water is thoroughly mixed with the bile, after which it is tubed and sterilized in an autoclave for 30 minutes at 15 lbs. pressure. The fermentation tubes employed are 140 mm. long and 15 mm. in diameter, having an elongated bulb about 40 mm. in its shortest diameter. This admits of the addition of 10 c. c. of the water to be tested without too great a dilution of the media.

A large number of market samples of evaporated or inspissated bile were tested, but they were all found to be very acid, and even when neutralized did not give proper results. It has since been established by experiment that if the bile is sterilized in an autoclave when freshly drawn and the filtered liquid evaporated to a dryness that this product when kept perfectly dry will remain practically neutral and can be preserved indefinitely. A combination of 110 grams of the solid bile and 10 grams of lactose, dissolved in a liter of distilled water will give the same results as the media made from fresh liquid bile.

It has been shown by extensive tables given in the article previously referred to that negative results for Bacillus coli have been often found by the use of Smith solution when there was no question that the germ was present but had been overgrown in the media and crowded out by other bacteria. On the other hand, experiments recently performed show that apparent positive tests for B. coli may be obtained when mixtures of gas producing bacteria other than B. coli are added to Smith solution.

The results so far obtained with bile lactose media point strongly to the fact that no gas producer or mixture of gas-producing bacteria will give results as high as 25% of gas except B. coli, even when three days' incubation is employed. The necessity for the absorption test is therefore eliminated.

In testing a water for B. coli, dilutions of 0.1, 1.0 and 10 c. c. are planted in the fermentation tubes and incubated at 37½° C. for 48 hours. All tubes giving over 25% of gas are considered to contain B. coli. Those having any considerable amount of gas, but still under 25%, are returned to the incubator for 24 hours longer. Attenuated B. coli will sometimes require 72 hours to give the positive test.

Underground waters not exposed to surface influences and properly filtered waters should not give positive tests in any dilution. Surface springs, open dug wells and pure surface waters may give positive tests in the 10 c. c. dilution, but in no less quantities. Moderately contaminated waters and those exposed to surface drainage containing small quantities of the excreta of the lower warm-blooded animals may give positive tests in the 1 and in the 10 c. c. dilutions. Such waters are to be looked upon with suspicion. Contaminated waters and those having a large amount of surface wash will give positive tests in the 0.1, 1 and 10 c. c. dilutions. For grossly polluted waters and sewages higher dilutions may be employed, as in testing sewages and sewage effluents from filters.

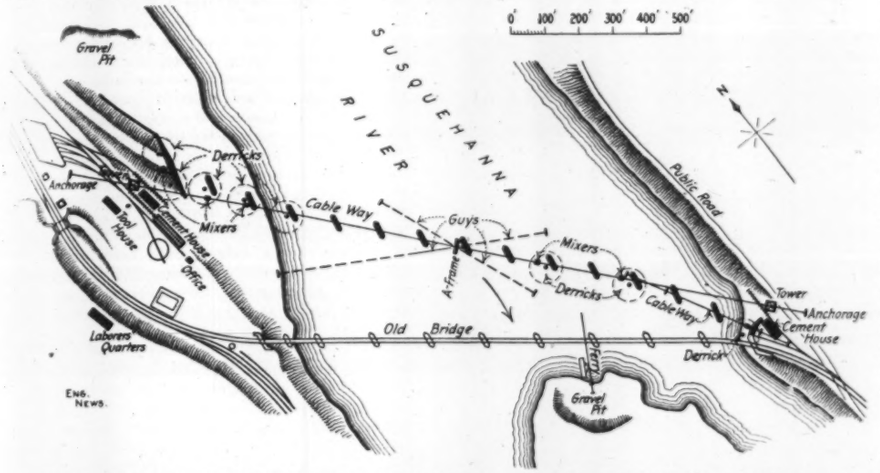


FIG. 4. PLAN OF CONTRACTOR'S PLANT USED IN CONSTRUCTING NEW BRIDGE PIERS, TOWANDA, PA.

At Mt. Prospect Laboratory about five thousand samples of waters of various degrees of purity and from hundreds of different sources have been tested by means of Lactose bile and the results have always agreed with the judgments formed by the complete analyses of the water, as well as by careful sanitary inspections of the individual sources of supply. In many instances contamination has been found to exist which would not otherwise have been detected.

The use of this media gives an exact gage of the purification brought about by systems of filtration, and in the New York City Department of Water Supply, Gas and Electricity six large sand filter beds and two mechanical filter plants, under the author's charge, are daily tested by this method as well as for quantitative bacterial removal.

CONCLUSIONS.—The bile media previously employed has contained too little bile salt to be effective as a selective inhibiting agent.

The use of the Lactose bile media herein described for the determination of B. coli prevents negative tests from the overgrowth of other bacteria, as well as positive tests from mixtures of other gas formers.

By the employment of this new media more definite results on the sanitary quality of a water may be obtained than by any other test at present in use. The media is also especially valuable in the testing of filter plants.

THE BIDS FOR THE PURchase of electrical energy developed at the water-power plant of the Chicago Drainage Canal have been rejected by the Sanitary District. Bids for the transmission lines to Morgan Park, Blue Island and Dolton have been received, but no contracts have yet been awarded.

THE MADRID RESERvoir, whose concrete roof failed with disastrous results two years ago, is to be left and operated without cover, according to a decision of the city council of Madrid, Spain, as reported by Mr. F. von Emparger in "Beton und Eisen."

SOME HIGH RECORDS IN BRICK TESTS.

At the recent meeting of the National Brick Manufacturers' Association, Lieut. J. A. Howard of Watertown Arsenal read a paper on the strength of brick in which were recorded some bricks and brick piers of unusually great strength. The strongest brick ever tested at the Arsenal was a paving brick from St. Louis, Mo., which showed a compressive strength of 38,446 lbs. per sq. in., with a modulus of elasticity of 8,510,000. The absorption was 0.21% by weight and 0.5% by volume. The sample tested was set on end and measured 2.45 × 3.09 ins. in cross section.

In the accompanying cut are shown some remarkable high records of other masonry specimens. The records are selected from a great number of tests made at Watertown Arsenal to show maximum records and should not be taken of course as any guide for the designing engineer.

The granite of 51,990 lbs. per sq. in. compressive strength came from a quarry in Asheville, N. C. Ordinary granites range from 20,000 to 30,000 lbs. per sq. in. The cement rock is the stone from which natural cement is made in the State of New York. The brick of 38,446 lbs. strength has just been described. Ordinary values for hard burned brick range from 12,000 to 25,000 lbs. per sq. in.

Portland cement, set under pressure, attained the maximum strength yet observed in this material. This sample was exposed to an initial pressure of 14,000 lbs. per sq. in. while setting. The strength given on the diagram was displayed by the cement at the age of 57 days. The compressed strength of ordinary Portland cement, tested neat, ranges from 6,000 to 9,200 lbs. per sq. in.

THE LA SALLE ST. TUNNEL under the Chicago River is now having its crown removed, and as the originally proposed new roof has not been built (for reasons stated in the article in our issue of March 7) this tunnel is now practically destroyed and abandoned. A steam drilling scow, as used in harbor improvement work, was employed to drill holes in the roof for blasting, and the site was dredged by a large dipper dredge of the Great Lakes Dredge & Dock Co.

FIG. 5. A-FRAME CENTER SUPPORT FOR LIDGERWOOD CABLEWAY SYSTEM.

PIPE SUBWAYS IN BRITISH CITIES AND IN PARIS.

The advantages of subways under city streets for the accommodation of water and gas mains, electric cables, etc., in order to facilitate inspection, repairs and renewals, and to avoid the tearing up of the streets for this kind of work, have several times been discussed in our columns. During a recent visit to Europe a member of the editorial staff of this journal made some inquiry as to practice in this respect in a number of English cities. Of 18 important cities, 7 have subways of this class, as described below. In some cases they are built over the sewers, and afford access to the latter by manholes in the floor of the subway, but in other cases this practice is not considered advisable, and the subways are built quite independently, connections being only made to the sewers for drainage. At Paris, France, however, a special form of combined subway and sewer has been extensively used for a number of years, and with good results. In some cases gas mains and electric cables are allowed in the subways, but in others it is not considered safe to admit them both, for fear of explosions due to gas leakage and electric sparks. Two subways for the use of electric cables exclusively are also mentioned.

FIG. 1. JUNCTION IN PIPE SUBWAY; LEEDS, ENGLAND.

In general, the opinion is favorable to the use of subways, as being advantageous and economical, but in two cases the objection is made that they do not provide against the repairs of the service pipes to the houses, and that such repairs are much more numerous than those to the mains themselves. This may sometimes be the case where there is a single subway in the middle of the street, but where this plan is followed lateral tubes or galleries are frequently built to accommodate the service pipes, which can thus be laid or renewed from inside the subway or the house vault. In some cases, however, there is a subway under each side of the street, so that the service pipes are easily taken care of. This was done in the construction of Kingsway, one of the modern wide streets of London, as described in our issue of July 12, 1906. The objections above noted come from Bristol and Hull, neither city having any subways, and we quote the statements below:

BRISTOL.—(362,220 population).—Some years ago, when a new street was being laid out through the old part of Bristol in order to give wider and more direct communication, the question of providing a subway was discussed, and I prepared plans and estimates. The gas and water supplies of this city are in the hands of private companies, each working under its own statutory powers. The water company did not object to the proposal, but was unwilling to contribute to the cost. The gas company declined to lay its pipes in a subway where electric cables were also carried. The provision of a subway for main supply pipes does not prevent the tearing up of the streets for laying and repairing the service pipes to the houses, these openings being much more frequent than those for repairs to the main pipes, when once the latter are laid. For the above reasons the proposal was never carried out.—T. H. Yabbicom, M. Inst. C. E., City Engineer and Surveyor.

HULL (256,000).—This city has done nothing in the way of constructing subways under streets for the accommodation of water and gas mains, etc. The view I have taken is that the advantages to be gained by such subways are in no way compatible with the cost. The practice in this town is to lay service mains for water, gas and electric light in duplicate in each street, one of each under either footway, and to lay the large feeding mains under the carriageway. In the new streets recently constructed in the center of the town, the main sewers also have been made in duplicate, one immediately outside each curb line; it is thus possible to connect any house or premises by breaking up the footway, only, and unless the subway was close to the building line or the houses were provided with vaults, the breaking up of the footway would be required in any case.—A. E. White, M. Inst. C. E., City Engineer.

Other large cities which have no subways are the following: Birmingham, Bradford, Exeter, Leicester, Liverpool, Norwich, Sheffield, Southampton and York. At Bradford the matter has been considered, and in April, 1906, Mr. J. H. Cox, City Surveyor, made an investigation as to other cities. We are indebted to him for a copy of his report, the information in which is given in connection with that from the several cities noted below. He states that at Sheffield the question has been discussed at different times, and in 1892 an estimate was prepared for constructing subways in some of the principal streets, which at that time were being widened. The estimate was a little over $100,000, but as the streets were being widened in sections (as they could be arranged for) and many pipes and mains would remain undisturbed, the cost was considered prohibitive. Mr. Charles F. Wike, M. Inst., C. E., City Surveyor of Sheffield, states that the idea has each time been abandoned, chiefly on account of other departments and companies not offering a sufficient contribution toward the cost of construction.

Coming now to the cities in which subways have been established, we give below the information furnished us by the engineers of the [illegible] cities, and also that obtained from the report of Mr. Cox, already noted.

LEEDS (450,000).

It is stated by Mr. W. T. Lancashire, Assoc. M. Inst., C. E., City Engineer, that the provision of subways under the streets has only recently been taken up, but 3,063 ft. have been built under this direction in a district of the city which is being entirely reconstructed. They have not yet been very extensively used, but are occupied by gas and water mains and electric light and telephone cables. In all cases the sewer is laid under the subway, and is accessible by shallow manholes in the subway floor. At St. Helens, on the other hand, this arrangement is considered objectionable, as stated further on. The dimensions vary from 5 ft. to 8 ft. in width and from 6½ to [illegible] ft. in height. The walls are of concrete, and the roof is in some case a semi-circular brick arch, and in others a flat reinforced-concrete roof. Fig. 1 shows a junction of two subways recently constructed under Quarry Hill. This shows the flat roof and the horizontal supporting brackets for pipes, etc. In addition to the above, the electric lighting department has also built a subway about 1,071 ft. long, extending from the main generating station; this is 11 ft. wide and 7 ft. high, and contains as many as 50 electric cables.

LONDON.

Subways were constructed in London as long ago as 1860, and have since been built in a number of streets. The duplicate subway system built very recently in connection with the construction of Kingsway, a new and important street, was described and illustrated in our issue of July 12, 1906. Mr. Maurice Fitzmaurice, M. Inst. C. E., Chief Engineer of the London County Council, states that under the present policy subways for water and gas mains, etc., are invariably built whenever a new street is formed. We are indebted to him for the cross-sections shown in Fig. 2, and for the by-laws relating to the use of the subways; as well as for the following list of subways now in use:

Pipe Subways in London.

	ft.		ft.
Garrick St.	300	Kingsway (East)	1,620
York St.	330	Kingsway (West)	1,620
Middlesex St.	525	Tower Bridge Road	2,400
Southampton Row (E.)	540	Rosebery Ave.	2,400
Southampton Row (W.)	540	Shaftesbury Ave.	2,700
Northumberland Ave.	930	Charing Cross Road	2,700
Commercial Road	1,140	Southwark St.	3,300
Aldwych (North)	1,410	Victoria Embankment	6,600
Aldwych (South)	1,410		
Strand	1,440	Total	35,595

The by-laws made by the County Council and approved by the Board of Trade, for the regulation and control of the use of the subways, deal with a variety of conditions and are enforceable by penalties. Notice must be given before any pipe or wire may be installed or removed (14 days, or three days for service pipes or wires); also three days notice of repairs, alterations or renewals to be made. The several owners must also file full particulars of each pipe or wire, its location, size, material, date of laying, etc. The requirements as to charges for the use of the subways are substantially as follows:

Every company, body, or person using a subway shall pay to the council on the usual quarter days in each year, fees and charges according to the following scale:

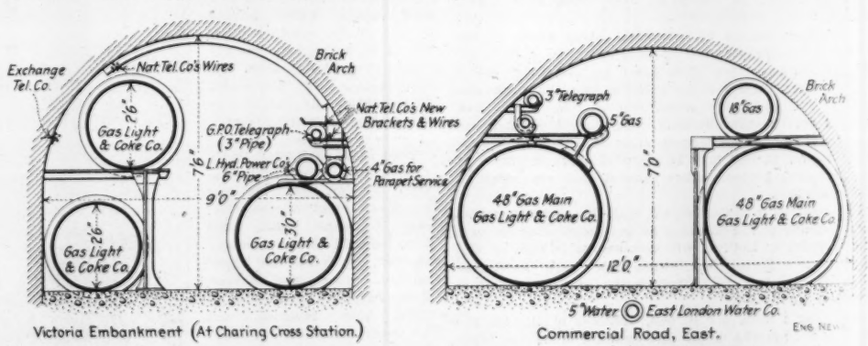


FIG. 2. CROSS SECTIONS OF PIPE SUBWAYS IN LONDON, ENGLAND.

(A) A charge of 5s. ($1.25) for each day or part of a day during which a pipe or wire is being repaired, or altered, laid in or removed from a subway.

(B) A charge of 1s. (25 cts.) for opening or closing a subway at any time other than that fixed for the daily visit of the council's officers.

For use of and supervision of the pipes and wires in each of the undermentioned subways, an annual charge of

For use of and supervision of the pipes and wires in any subway not specified above, an annual charge as settled; provided that the annual charge in respect of a pipe or wire extending along the whole length of a subway shall in no case be less than $5.†

For each junction box, valve or other addition to the space occupied by any pipe in any subway, an annual charge of $2.50 per cu. ft. or part of a foot occupied between the limits of the pipe or wire.

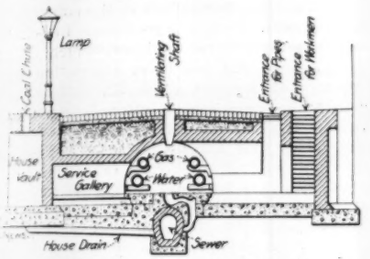


Fig. 3. Cross Section of the Farringdon St. Pipe Subway; London, England.

In the report of Mr. Cox, which has been already mentioned, it is stated that it is usual to build subways in new streets, but that no attempt has been made to provide them in old streets, as the cost would be prohibitive. Their construction has been found to be both advantageous and economical. The size varies, but they are generally 7 to 8 ft. high in the center (with arched roof) and 8 to 12 ft. wide; the depth from the street level to the roof ranges from 3 ft. to 15 ft. They are built of brick, and cost $55 to $105 per lin. yd. Gas and water mains and electric cables are laid in the same subway. In regard to the London subways we give extracts from two reports: (1) A report made in 1895 by Mr. T. de Courcy Meade, City Surveyor of Manchester, when the corporation of the latter city was considering the construction of Fairfield St., and a committee had suggested the advisability of constructing a subway for electric cables, sewers, pipes, etc.; (2) a report made in 1902 by a council committee of Glasgow (including Mr. Thomas Nisbet, Master of Works) in connection with the proposed Albion St. subway, described further on:

MR. MEADE'S REPORT.—A complete system of street subways was constructed under Holborn Viaduct, and other new streets formed in connection with the Holborn Valley Improvement Scheme, about 30 years ago. The most important of these structures is that beneath the roadway of the Holborn Viaduct. There is a subway on each side of this thoroughfare, with a series of cellars between the subways and the buildings; the carriageway between these subways is carried on semi-circular arches. A sewer is formed below the subways, to which the house-drains pass. The subways vary in form, owing to differences in level and other causes.

The entrances to the subways at Farringdon St. (which is at a lower level than the viaduct) are by large iron gates; there are also entrances by closed iron doors, with open gratings over them, in Shoe Lane; and at the eastern and western ends of the viaduct there are openings similar in character to those ordinarily used in entrances to the sewers, beneath which are flights of steps for the entry of workmen (Fig. 3). Openings are also provided for the purpose of lowering pipes into or taking pipes from the subways (as shown). The ventilation of these subways has been carefully considered. They are ventilated by the following means: (A) by shafts from the crown of the arch, terminating by open gratings 12 ins. diameter at the footway level; (B) by circular flues, 8 ins. diameter, which start from the crown of the arches and pass over the house vaults; these openings were provided with the intention of being carried up in the party walls of the adjoining houses when erected; (C) by openings connected with the lamp-posts on the public footways, the lower part of each post being perforated to afford ventilation; (D) by air bricks built into the walls between the subways and the house vaults; (E) by openings in the gates, so that a good circulation of air is always maintained.

The subways are lighted by gratings in the footways, fitted with glass lenses, and placed at intervals of 40 ft. These render certain portions of the structures sufficiently light by day for the purposes of inspection and work; other parts have no daylight except that obtained through the ventilating gratings in the footways, but provision is made for artificial lighting throughout the whole of the subways by gas jets suspended from the crowns of the arches, and connected with the gas mains. In order to afford a supply of gas and water to the houses, square iron tubes are built into the walls between the subways and the house vaults, through which the service pipes connected with the mains in the subways are passed. The water pipes are supported by iron chairs; the gas, telegraph, and other pipes are carried on wall brackets. All the chairs and brackets are so arranged as to afford ample space around each of the pipes for workmen to get to every part of them.

The water mains are provided at places with stop cocks, air valves, and emptying cocks which discharge into the sewers, and hydrants for washing out the subways; branch pipes are also carried from the water mains through the roof of the subways to the street surface, for the purpose of supplying hydrants for street watering and fire extinction. The service pipes for the street gas lamps, and wires for electric lighting, are carried in a similar manner to the street surface, and the gas pipes are so arranged that any leakage of gas which may take place escapes immediately into the street through perforations in the base of the lamp columns. The gas mains are fitted with stop cocks and syphons. These appliances are usually placed beneath the surface of the streets, but in the subways are perfectly accessible. Provision is made for supplying gas, water, and electricity to each house along the line of the street. Provision is also made beneath the Holborn subway for a pneumatic dispatch tube. The temperature in the subways is a matter of importance. During the past winter the lowest temperature recorded was 36° F. while the outside temperature at the same date was 13° below freezing point. The pipes in the subways have been painted from time to time, and there is no appreciable corrosion on their external surface.

Subways have also been constructed in several of the modern thoroughfares in London under the direction of the Metropolitan Board of Works, and more recently by the London County Council. In the construction of the subway and side vaults beneath the Victoria Embankment, the subway is formed in the center of the carriageway, and is ventilated by shafts terminating at the street surface, and protected by iron gratings; there are side passages between the subway and the area vaults for the purpose of passing gas and water service pipes to the buildings. The sewer is formed under the center of the subway, and the house drains are placed under the side passages; this form of construction is more simple and much less costly than that adopted at Holborn Viaduct.*

The London subways are probably the most complete of their kind, but from their extent and the special circumstances caused by the variation of levels of intersecting streets, their construction was of a very extensive and costly character. Accommodation for future extensions of pipes and mains and for convenient access, also for means of lighting and ventilation, were well considered; and since the subways were constructed there has been no occasion to break the street surface for the supply of gas or water, or for other purposes.

The entire cost of constructing the London subways outside the city area is borne by the London County Council in the first instance. The owners of the pipes, etc., that are subsequently laid in the subways are charged an annual sum, which in some cases is of the nature of a rent, and in others is merely a charge for supervision, as each subway is patrolled daily by the council's inspectors. The reason for the different charges is that some companies (water, gas, etc.) had a statutory right to break up streets and others had not. In no case, however, even if all users paid rent, would the cost of constructing the subway fall entirely on the users. Mr. A. R. Binnie, then the London County Council's engineer, stated that it was felt, when the matter was considered by the council, that the convenience to the general body of ratepayers arising from the streets not having to be stopped up (partially or entirely) for pipelaying was so great as to warrant part of the cost being borne as a public expense.

The engineer to the New River Water Co. (Mr. E. Collins) is of opinion that the Holborn subways were constructed of the requisite size, but that the subway which the late Metropolitan Board of Works had constructed in Queen Victoria St. (12 ft. wide by 8 ft. high) was too small for the locality and was now so full of pipes there was no room to get into it. If, therefore, any accident did occur in it, the cost of repairs to mains would be very considerable. With regard to the cost of laying mains in subways, he found that by getting pipes first into the subway, so that they had a clear run without the obstacles of other mains, the cost of laying was about the same as that of laying in the ordinary way beneath the street surface. In his experience of subways there were no breakages or bad accidents, and one of the great benefits of them was that all pipes could be seen from time to time, a most important consideration with water mains, in which fractures often commence with a little unseen drip, and finally end in a collapse.

MR. NISBET'S REPORT.—As regards London, the subways have been, and are being, constructed under the provisions of the London County Council (Subways) Act, 1893. From the date of that act till now subways have only been formed in new streets or in streets that were being widened. In new streets the companies or departments which use the subways put their pipes or wires therein at their own expense, but in existing streets that are widened by the County Council the pipes and wires already there are, in the course of the widening, transferred to the constructed subway. The first cost of such transfer is borne by the County Council, but the maintenance and subsequent renewal are at the cost of the company or department owning the pipes or wires. The necessary connections from the adjoining buildings to the subway are formed of 9-in. pipes. One of these connections is provided at every existing house, and, where houses are not erected on the adjoining ground, a connection is provided at distances of about 25 ft. The connections made by the County Council do not extend beyond the line of the curb from the wall of the subway. The owner or occupier pays the cost of connecting with the main. In all cases the street sewer is under the subway, but a connection is made from the subway to the sewer for the purpose of draining the subway. Gas, water, telephone and electricity pipes and wires are provided for in the subways. As regards the risk of explosion, no great fear was entertained, as any serious escape of gas would soon be noticed at the times of inspection. As to the inconvenience arising from one of the large pipes getting broken, this was regarded as a remote contingency, but if it happened the subway might have to be broken into from the surface of the street. The main advantage of the subways was the prevention of openings of the street. It was suggested that Glasgow, owning, as it does, the gas and water undertakings, might have other and further advantages than London has. In subways constructed in new streets the pipes are, of course, put down before the upper part of the subway is completed and covered over. Openings are left for access to the subway. When additional pipes are to be put down, the pipes are taken to those openings and, when inside, are taken along the subway one way or other as required. The companies objected to this course

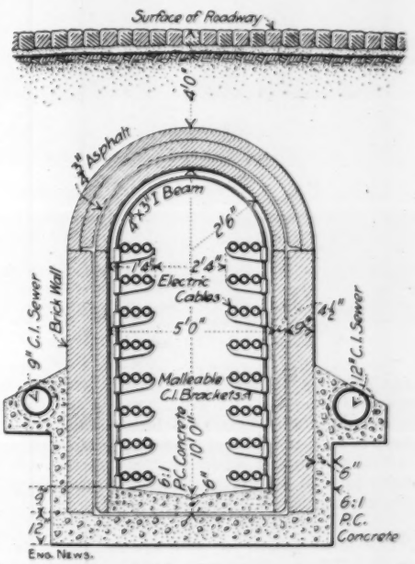


Fig. 4. Cross Section of Electric Cable Subway at Manchester, England.

[*This charge varies for different subways of different lengths and with the different sizes of pipe. For water and gas companies having power to break up streets it ranges from $10 to $25 for 3-in. to 6-in. pipes, and from $15 to $250 for sizes over 36 ins. For other companies, bodies or persons having power to break up streets, it ranges from $10 to $150 for 3-in. and under, and from $25 to $420 for 12 to 18-ins. The word "pipe" includes tubes for wires or other purposes. These charges are for the use of the entire length of a subway, and a reduction will be made when only a portion of the length is used.—Ed.]

[†This charge is for each 300 ft. of pipe; it ranges as follows, and is the same for all subways: For water and gas companies, from 60 cts. for sizes smaller than 3 ins. to $12.50 for sizes over 36 ins. For other companies, from $6.50 for 3 ins. and under to $20 for 12 to 18 ins. In these charges, the word "pipe" includes a main, tube or wire, but does not include a junction box, valve or other addition to the space occupied by any pipe in any subway.—Ed.]

[*The Victoria Embankment subway is of arched section, 12 ft. wide and 7½ ft. high, its crown coming close to the street surface. Brick manholes in the flat floor give access to the sewer, which is of egg-shaped section. The arrangement is very similar to that at Nottingham, shown in Fig. 5, except that in the latter case there is no manhole, and the sewer pipe is carried up into the side passage, while in the Victoria Embankment subway this pipe extends beneath the vault—Ed.].

as being more expensive than simply opening a trench and putting the pipes down where and as often as needed. The openings are from 300 to 1,050 ft. apart, but those distances are determined according to circumstances and requirements. The cost of the subway is from $175 to $200 per lin. yd.

At what is called the Strand Improvement there is to be one subway, 10 ft. by 7 ft. 6 ins., on each side of the principal street to be formed between the Strand and Holborn.* There is, further, to be one subway in the center of each of the smaller side streets. Originally it was proposed to have but one subway in the center of the principal street, and it was intended to be 12 ft. by 7 ft. 6 ins., but the later proposal to construct one on each side of that street is considered the better one. The County Council is so satisfied with the existing subways (nine in number) that they have had no hesitation in resolving to extend the system on this large scale in the streets to be reconstructed and widened under the Strand Improvement Act. In that improvement existing streets are being widened, and in the widened part the subways are to be formed, and that is the nearest approach they have had to the formation of a subway in an existing

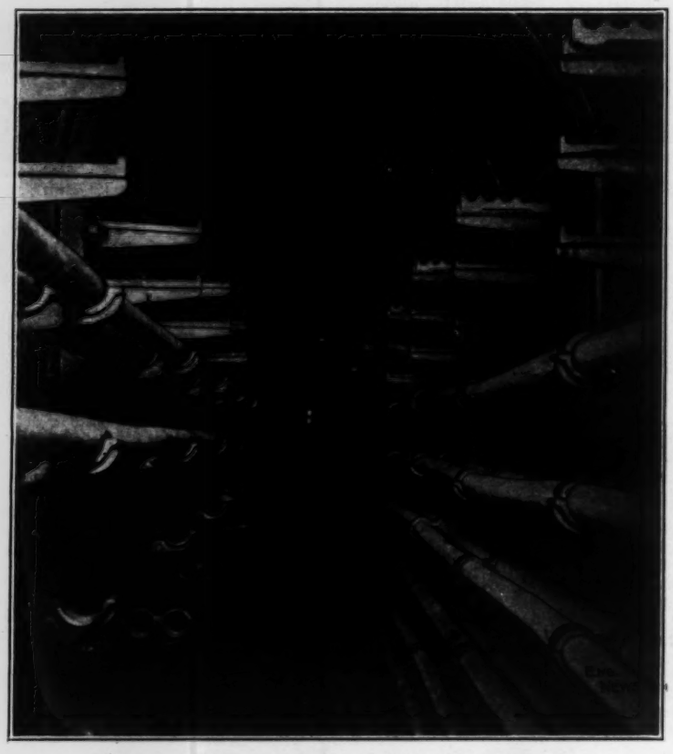


FIG. 5. INTERIOR OF THE MANCHESTER SUBWAY.

street. We traversed the subways in Charing Cross Road and Shaftesbury Ave., each of which is about half a mile in length, and found them clean, well kept and ventilated, and that their whole construction and condition were such as justified the County Council in claiming that they very fully served the purposes for which they had been called into existence.

MANCHESTER (600,000).

This city has a subway 7,386 ft. long, which was designed by Mr. T. de Courcy Meade, City Surveyor, and built in 1902. Fig. 4 is a cross-section, and Fig. 5 is an interior view beneath Stuart St. It is used exclusively for electric cables, and in the report of Mr. Cox the cost is given as $116 per lin. yd., including alterations to the existing street drainage system.

NOTTINGHAM (250,000).

The total length of subways in this city is about 2,775 ft. They were built by the city, and the design is shown in Fig. 6, from drawings furnished us by Mr. Arthur Brown, M. Inst. C. E., City Engineer. The subways contain gas and water pipes, pipes containing telephone and telegraph wires, and brackets carrying electric light cables. They are 10 x 8½ ft., of brick and concrete, with about 18 ins. from the crown to the street. Mr. Cox gives the cost as $125 per lin. yd., including vaults and the lateral passages from the subways to the vaults. The following particulars are from a statement prepared by Mr. Brown some time ago for the information of the City Engineer of Manchester:

The first subways which were constructed in this country outside of London were those in Victoria St. and Queen St., Nottingham, in 1861-62. These were followed a year or two later by subways in Sister Gate and Market St.; and in the year 1886 subways were formed in Albert St. and Wheeler Gate. Besides the gas and water pipes and connections there are no less than six pipes containing telegraph wires in the Victoria St. subway, and no stones were disturbed in the carriageway of that street for 25 years, nor was there any money spent on the repairs of the street during that period. At one of the recent subways in Nottingham, the street on the west side is 48 ft. wide, and that on the east side 50 ft. wide. The subway proper is 10 ft. wide and 8½ ft. high, with a semi-circular arch. It is ventilated by means of gratings at the surface level of the street, placed about 48 ft. apart; also by three side entrances, and by an open grating at a refuge in the lower end of the street. The side-ways or galleries, which form the means of communication between the subway and the vaults, are placed ordinarily 40 ft. c. to c., and are 4 ft. high and 3 ft. wide. The sewer is constructed under the floor of the subway. Under the sidewalk on each side of the street, vaults are constructed, 8½ ft. wide by 9¼ ft. long, and about 7 ft. high. These vaults are rented by the purchasers of the building lots adjoining. The floor of the subway is laid with cement concrete, and the floors of the side-ways and vaults are laid with bricks. Along and under each sideway is laid a 9-in. pipe, with a disconnecting trap and air inlet; and on the house side of the trap is a right and left-hand junction for receiving the drainage from the properties.

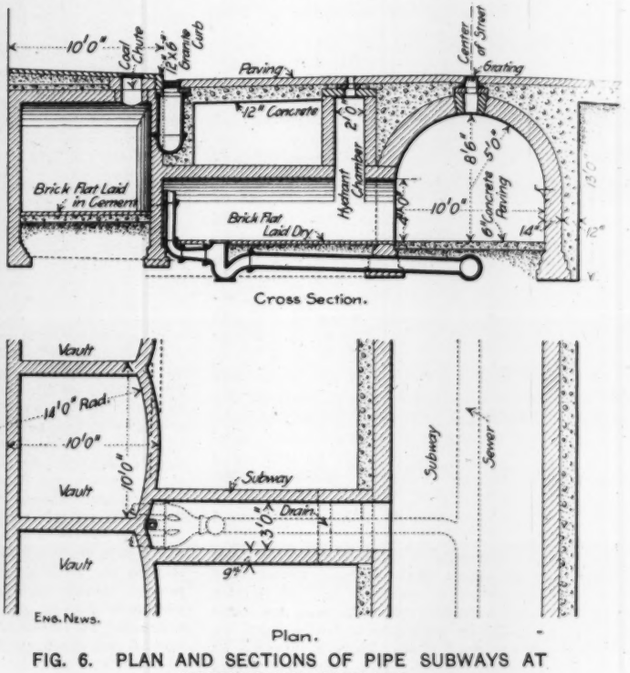


FIG. 6. PLAN AND SECTIONS OF PIPE SUBWAYS AT NOTTINGHAM, ENGLAND.

In the subways are fixed brackets, upon which may be placed pipes containing telegraph and telephone cables; the gas, water, and any other pipes are laid on the floor of the subway, or on iron standards fixed to the floor. At convenient distances, hydrant chambers are built over certain of the side-ways, in which are placed the fire hydrants and valves. The life of the iron pipes and connections in the subway is practically everlasting, as there is no rust, and the expense of relaying mains, and especially gas services, through this cause is saved.

During the severe weather in the early part of 1892, the maximum, minimum, and 10 a. m. temperatures inside the Albert St. subways were taken, and corresponding readings were taken outside the subway. The results of these observations show that the lowest reading in the open air was 19.2° F. on Feb. 19, and the lowest readings in the subway were 40.7° and 41° F. The range of temperature taken over the series of readings was 34.2° for the outside temperature, and 5° inside the subway.

The cost of the subway proper, including side entrances, side-ways and everything appurtenant to the subway itself, was about $50 per lin. yd., exclusive of the cost of the sewer. The vaults under the causeways cost about $100 each, or about $60 per lin. yd. of street; these vaults are let on a rental of $5 each per annum. The subway proper cost about $15,000, and 169 vaults cost about $16,900; 3½% interest on the cost of constructing the subway proper equals $525, and the profit on the vaults is 1½%, as the money is borrowed at 3½% and 5% is charged. This equals about $250, so that the net annual interest is $275 for the subways in the two new streets last referred to. In the case of new main streets, and where main thoroughfares are improved and widened, the opportunity should be seized to lay down subways in order to minimize as much as possible the evils resulting from the continuous taking up and relaying of streets.

ST. HELENS (90,000).

The following particulars of the subways of this city are taken from a report made in 1902 by the council committee of Glasgow, which report has already been referred to in connection with the subways of London. The St. Helens subways were built under the direction of Mr. Geo. J. C. Broom, M. Inst. C. E., Borough Engineer, who informs us that wires and cables have now also been put in for the Post Office (government) telephones, the National Telephone Co., and the electric lighting system of the city:

In connection with the purchase of the street railway system by the corporation, and the decision to relay the lines and equip them for electric traction, the question of the construction of a subway in the main business thoroughfare was brought before the council. The argument in favor of the construction of such a subway was very much strengthened by the fact that the whole of the surface of the street had to be disturbed for the purposes of constructing a new main sewer, of renewing the gas and water mains and services, and of laying of electrical cables. The question was therefore whether it would not be more economical and satisfactory, in view of the narrowness of the streets, the number of the mains, and the costly and unsatisfactory results of interfering with the surface and foundation of the streets, to construct a subway by which the whole of the works beneath the surface could be properly inspected, repaired, and renewed from time to time, without in any way interfering with the traffic and the convenience of the business people after the work had once been completed. On receiving the report of their engineers, the corporation resolved to construct a subway in Ormskirk St., Church St., and Raven St., for which plans were prepared by the borough engineer, and adopted by the council. The plans showed a subway constructed of concrete, with the exception of a 4½-in. ring of blue brick to form the arch round which the concrete was to be laid. This concrete also formed the bed for the paving of the streets. The subway is 6½ ft. high and 5½ ft. wide, the total length being 680 yds. The form of construction and the arrangement of the mains are shown in Fig. 7.

The subway is ventilated by means of open gratings 100 ft. apart. Side entrances have been constructed on the footpath at each end, and there is also, midway between them, an opening in the footpath, 14 ft. long by 9 ft. wide, through which gas and water pipes can be

*Engineering News, July 12, 1906.

conveyed when required. This opening is covered with Hayward prismatic lights and is provided with means of access and fencing for protection during use. The subway has an inclination corresponding with the surface of the street, and is drained at frequent intervals by means of trapped gullies connected with the sewer; further, a special valve is inserted in the lowest portion of the subway, to be used in emergency, should a serious outbreak take place in the water mains. The subway is lighted throughout by electricity, all fittings and switches, etc., in connection therewith being water and air tight, and every precaution has been taken so that, in case of a leakage of gas, the light can be turned on without fear of explosion. The lights are 28 ft. apart, and arranged in groups of five, with pilot lights between, the whole being controlled by main switches in the center chamber. The positions of all intersecting streets, as

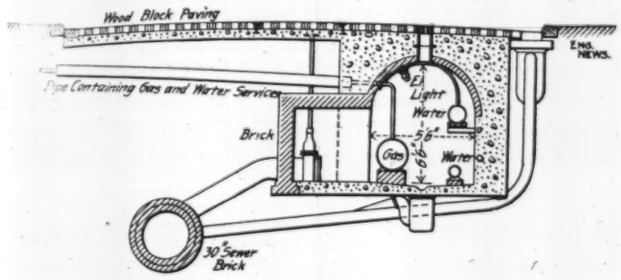


FIG. 7. CROSS SECTION OF PIPE SUBWAY AT ST. HELENS, ENGLAND.

also of all important buildings, are as in the London subways, indicated by means of plates fixed to the wall.

The subway at present contains one gas main, 18 ins. diameter, and two water mains, one 10 ins. and the other 6 ins. diameter. The service pipes for both gas and water are passed through 6-in. earthware pipes beneath the roadway, where necessary, to the curb on either side of the road. Due provision has also been made for carrying the telephone and electric light cables, and these will shortly be laid. The work of constructing the subway, together with the laying of the gas and water mains and street railway lines, and paving of the street, was carried on simultaneously.

The different departments of the [municipal] corporation bore the expense of removing from the street the old pipes and of substituting new pipes in the subway. The gas, water and electricity departments of the town are all under the corporation. The subway was made by the Highways Department. The public sewer in the street is not underneath the subway, and, in the opinion of the city engineer there, should not be underneath. There are gratings in the floor of the subway, and through these sewage might find its way into the subway, but that would mean a surcharged sewer and a rise of from 4 to 5 ft.; thus there is no chance, under ordinary circumstances, of sewage getting into the subway. The engineers of the gas, water and electricity departments were all in favor of the construction of the subway, and are in favor of the extension of the system. The gas and water engineers are further agreed that the proximity of their pipes does not affect each other. Sufficient connections have been left to go to every house, and for each property one connection is provided. The total cost of constructing this subway was about $25,000, and the annual cost for interest and sinking fund is $1,720, which is paid by the three departments who use the subway, viz., the gas, water and electricity departments. There is no assessment for the subway. The telephone lines of the post-office are in the subway, and the post-office pays, by arrangement, the sum of $25 per annum for the use of the subway. Since the construction of the subway there has not been any difficulty from the escape of gas; inspectors from the gas and water departments go through the subway, and examine the pipes regularly once a week.

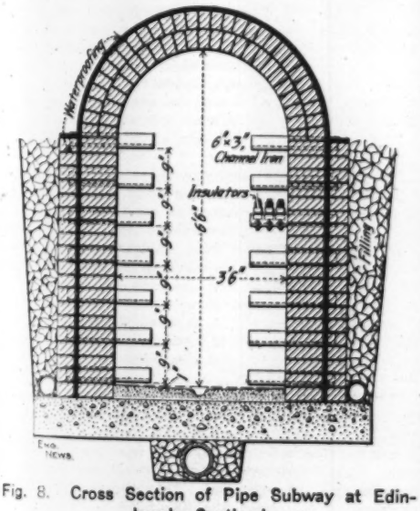


Fig. 8. Cross Section of Pipe Subway at Edinburgh, Scotland.

EDINBURGH.

The only subway here, as at Manchester, is for the exclusive use of electric mains. Mr. James Massie, Borough Engineer and Master of Works, states that it is 3,228 ft. in length and 3½ × 6½ ft. in section. Its construction is shown by the cross-section in Fig. 8.

ABERDEEN.

This city also has a subway for electric cables. This was built in conjunction with a main sewer, the flat floor of the subway being directly above the crown of the sewer for the greater part of the way. The subway is 4,500 ft. in length, and for about half this distance it is of horseshoe section, with brick sides and arch and a flat concrete floor. A waterproofing course of bituminous felt is laid between the brick and the concrete backing. Below the concrete is a tile drain in a trench filled with broken stone. This part of the subway is 6 ft. 6 ins. high and 4 ft. 6 ins. wide at the roof springing, the side walls having a radius of 14 ft. 9 ins. The remainder of the subway has battered side walls, supporting a segmental and roof of 3 ft. radius; the height is 7 ft. at the sides, with a width of 3 ft. 6 ins. at the bottom and 4 ft. 8 ins. at the top. At one point the distance between the street and sewer required the subway to be reduced to 5 ft. in height; here it is made 5 ft. wide at the bottom and 5 ft. 10 ins. at the top, with a flat roof of 6-in. I-beams placed 42 ins. c. to c. The concrete filling is reinforced with expanded metal. The cost was about $93,000, including alterations to sewers encountered, or a little over $20 per lin. ft.

GLASGOW (800,000).

Mr. Thomas Nisbet, Assoc. M. Inst. C. E., Master of Works, states that very little has been done in the way of constructing subways. One was built in Albion St. about two years ago, and it has been decided to build another under a sidewalk where a street is being widened. The Albion St. subway is 345 ft. long, 6 ft. 6 ins. wide and 7 ft. high, with a depth of 12 ins. from the street surface to the crown. The cross-section is shown in Fig. 9. At each end is a lateral passage from an entrance manhole. Mr. Nisbet's report of 1905 stated that there were two 8-in. gas mains, a 7-in. water main, three hydraulic power-supply mains, and two 3-in. electric conduits. The southern end is used by the telephone department as a chamber giving access to its mains. There are 73 cross connections from the conduit to the curb line. The total cost, including these cross connections and the electric lighting of the subway, was $6,097 ($53 per lin. yd.).

THE COMBINED SUBWAY AND SEWER SYSTEM OF PARIS, FRANCE.

In most of the cases noted above the subways have been established on a small scale, isolated in individual streets and not as part of a complete system. In the great scheme of the municipal improvement of Paris, however, which was started under the direction of Baron Haussman about 1851, a comprehensive system of subways was included, the main sewer being designed to form both sewers and subways. These subways are of arched form, with flat floor, and in the middle of the floor is the trench or channel forming the sewer. They were briefly described in our issue of June 2, 1904.

The main sewer, under the Sebastopol Boulevard, on the left bank of the Seine, is 11 ft. high and 16 ft. wide. Mr. T. de Courcy Meade, of

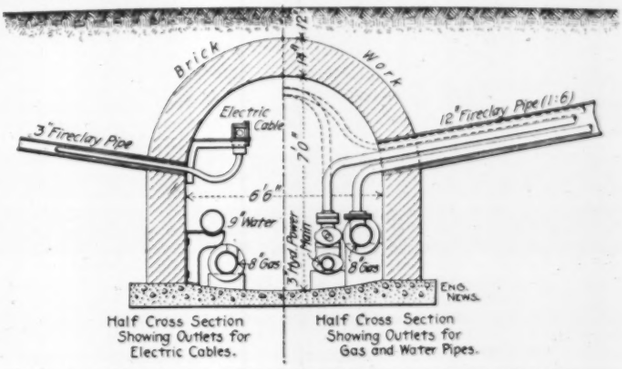


FIG. 9. CROSS SECTION OF ALBION ST. PIPE SUBWAY; GLASGOW, SCOTLAND.

Manchester, whose report has been mentioned above, states that he was much struck with the extreme cleanliness of the Paris subways, which were systematically washed out, and in spite of the sewer channel there was very little unpleasantness experienced when walking or riding through the subways. A section of the Boulevard Sebastopol subway is shown by Fig. 10. The sewer channel is about 5 ft. deep and from 3 to 4 ft. wide, while in some of the intercepting sewers the width of this channel is 9 ft. The 42-in. water main and a main for river water (which is supplied to manufacturers and others for industrial purposes) are both supported on cast-iron standards. Above those is a pipe for the compressed air supply system, and also the pneumatic tubes for conveying telegrams and messages. The telegraph and telephone wires or cables are carried on brackets on either side of the arch. Some of the smaller subways are of horseshoe section, 6⅞ ft. wide and 7½ ft. high, the height including a sewer channel 2½ ft. wide and 1⅞ ft. deep, placed so as to form a wide berm or floor on one side and only a narrow berm on the other side. In Mr. Nisbet's report, mentioned above, it is stated that gas mains and electric cables are not put in the subways, for fear of explosion. From this report we take the following extract:

> In putting in a new pipe it is done by boat or stage, and if anything goes wrong with any pipe it is repaired by the company or department owning it; subject, however, to the supervision of the chief engineer of the municipality. When a new connection is wanted to the subway, provision is here as elsewhere, made by forming branches between the particular houses adjoining the streets and the subway. All the pipes connected with the houses are taken through the branches or connections of the subways. The subways are connected with the cellars of houses. Subways formed in streets where there are only private houses are 6 ft. in height and 3½ ft. wide, the cost being from $9 to $10.75 per lin. yd.
>
> The municipal representatives and the officials stated that they never received complaints from persons as to

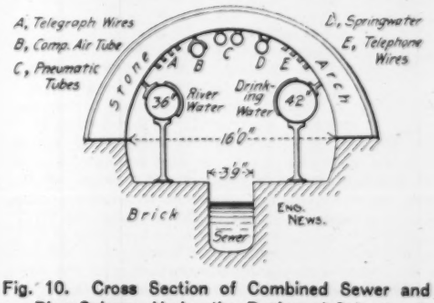


Fig. 10. Cross Section of Combined Sewer and Pipe Subway Under the Boulevard Sebastopol; Paris, France.

smells escaping into the streets through the gullies; all the street gullies are open for the ventilation of the sewers, and although we traveled a considerable distance immediately above the run of the sewage, we noticed little or no offensive odor.

The whole system of subways is so perfect, and is on such an elaborate but methodical and practical scale, as to excite nothing but admiration. The subways are on a much more extensive and general scale than in London. Of course it will be kept in view that the primary object in the construction of those subways in Paris was for the conveyance of sewage, but they are constructed on such a large scale and of such dimensions as to admit of the reception of water pipes for domestic as also for manufacturing purposes. On the other hand, the subways constructed in England are wholly for the reception of gas, water, and other pipes, leaving sewage to be otherwise conveyed.

The effect of the difference in the construction of a subway primarily for sewage as against one for pipes and wires is that in the former the level and grades are determined by the necessity of getting suitable fall for the sewage, and it may happen that the sewage runs at a comparatively shallow depth at some parts, while at other points it is at a considerable depth. In the latter case, the course of the subway containing the pipes and wires runs parallel to, and comparatively near, the surface of the street, and the main and outstanding advantage of constructing such a subway for pipes and wires alone is that the upper part of the subway is available as a foundation for the paving of the street.

DRAINAGE OF BOTTOM LANDS ALONG THE MISSISSIPPI AND MISSOURI RIVERS.

An important class of engineering work in many of the central states is that of land drainage and reclamation. In some cases the work includes the construction of levees to protect low lands from floods, but the greater part of the work consists in draining away the water upon or in the soil. This work may be divided into two classes: (1) The drainage of large tracts of marshy or swamp lands by means of ditches and canals, sometimes supplemented by tile drains; (2) the drainage of relatively small areas of farm land, usually by tile drains, sometimes supplemented by open ditches. Two interesting papers covering these two classes of work were read at the recent annual meeting of the Illinois Society of Engineers and Surveyors at Peoria, Ill., Jan. 25, and abstracts of both of these are given below.

THE SNY ISLAND LEVEE DRAINAGE DISTRICT.

By W. P. BUSHNELL.*

This district was organized in 1871, being the first one formed in Illinois, and comprises 110,000 acres situated in Adams, Pike and Calhoun counties, which are protected from inundation by the flood waters of the Mississippi by 52 miles of levee, constructed in 1872-3, beginning about ¾-mile southwest of Bluff Hall, in Adams County, and extending down the left bank of the river to Hamburg Bay in Calhoun County. A large portion of the lands reclaimed consisted of a series of long, narrow islands known as Sny Islands, which were cut off from the main Illinois shore by a deep, narrow, and tortuous channel which left the main channel of the Mississippi about 15 miles below Quincy and finally returned to the river about a mile below Clarksville, Mo. It was from these islands that the district derived its name.

The district was laid out and the levee constructed according to surveys made by E. L. Corthell, M. Am. Soc. C. E. The eastern boundary line is the high-water mark of the flood of 1851. The original grade of the levee was intended to be identical with the flood plane of the same year. As originally constructed, the average height of the levee was 8.2 ft., with a width of crown of 5 ft., and with side slopes of 3 to 1 on the river side and 2 to 1 on the land side. The levee, as originally designed, was too low, and consequently of too small cross-section. This may have been due to lack of funds. The grade should have been from 3 ft. to 5 ft. above the flood plane of 1851, and the width of the crown should have been not less than 8 ft., which, with the attendant widening of the base, would have materially increased the cross-section.

In many places the line of the levee was located so near to the shore line of the river that dirt sufficient to build the levee could not be obtained between the levee and the river, and was taken from the land side, where all of the borrow pits were too close to the levee and most of them were too deep. Another mistake was in making use of railway embankments at three places instead of building an independent levee. Of the 52 miles of the Sny Levee, about 2.66 miles are railway embankments, and buried trestles have caused these embankments to give way in two or three instances. The railway embankments are not constructed with a view to excluding high water, and should never be used for that purpose. Passing heavy trains over levees under pressure of high water is dangerous and sometimes disastrous to the embankment.

According to statements of sub-contractors and laborers who assisted in building the original levee, the specifications governing the materials used in the levee and the preparation of the foundation were utterly disregarded, except when the engineers were present. In their absence the foundation was not properly cleared and broken, and stumps and logs were covered up where they were left to decay and weaken the structure, in some cases causing its destruction. Prior to the time when the levee was raised and enlarged after the flood of 1888, no less than 18 breaks occurred in it. All of these crevasses resulted from one or more of the above mentioned defects. Since 1888 no crevasses have occurred in the levee proper, although in June, 1903, a portion of the Chicago & Alton Ry. embankment gave way about 1½ miles east of Louisiana, Mo., forming a crevasse 534 ft. in length and varying in depth from 20 ft. to 60 ft. It occurred where an old trestle bridge had been filled in and left to decay and weaken the embankment.

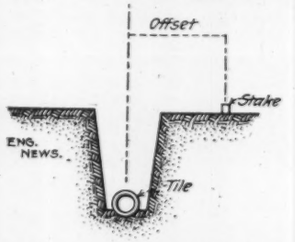


Fig. 1. Arrangement of Stakes for Trenches for Tile Drains.

The maintenance of the levee requires almost constant work and watching to prevent it from being weakened by muskrats, woodchucks and other burrowing animals, and to keep it free from brush and trees, the roots of which penetrate the embankment and prove a menace during floods.

While the stage of the river is 2 ft. or more above the "danger line" a patrol is maintained from one end of the levee to the other; and during extreme floods, the patrol is doubled or perhaps trebled or quadrupled and is maintained both day and night. In addition, camps of laborers are established in the vicinity of places where special weakness may have developed. Weak places are reinforced and strengthened in various ways by the use of sandbags and burlap, copious supplies of which are kept on hand at all times, being distributed and stored at convenient points. It is said that the flood of 1888 cost the district $14,000 for labor and materials employed in efforts to maintain the levee. The first cost of the levee is said to have been about $500,000, and the amount expended in repairs and in enlarging and strengthening the levee to the present time is about $502,000. All the weak places developed by the flood of 1903 have been repaired and strengthened, and the levee is being reinforced with banquettes as fast as funds are available.

The internal drainage of the district depends for a main outlet entirely on the natural waterway above mentioned, named by the French explorer Chenal E'Carte, but more commonly known as the Sny. The levee was built across this channel near the head of it and near each of its numerous mouths and an outlet into Hamburg Bay was provided by the construction of two or three short canals connecting a series of natural sloughs and lakes, and leaving nature to do the rest. The general course of the Sny parallels that of the Mississippi River, but is so crooked that its length greatly exceeds that portion of the river. The fall of the river here is about 6 ins. per mile, while that of the Sny averages only about 0.35 ft. per mile.

As the construction of the levee across the head of the channel robbed the Sny of its current and deprived it of the scouring effects of flood waters, the channel has been gradually filling up until the width of the actual channel has been reduced in many places to 40 ft. or 50 ft. from an original width of 300 ft. Prior to 1903, dredging had been done in the Sny to the amount of perhaps $75,000. A large dipper dredge is just finishing an $80,000 contract, and a suction dredge, owned by the District, is working on a large bar in the upper portion of the Sny.

The drainage area embraces a total of about 400,000 acres, 110,000 being the low, level lands of the district, the remaining 290,000 acres are the hill lands contiguous to the district on the north and east, with elevations ranging from 100 ft. to 400 ft. above the bottom lands. The waters from these high lands come tumbling down into the bottom carrying with them vast quantities of silt, sediment, shingle and even large stones. No less than 13 large creeks, together with brooks, rivulets and ravines almost innumerable, provide avenues of approach for these waters to the lands of the district, where, if left untrammeled, they lose their channels and spread over the low lands and destroy or impair the utility of the fe[illegible]lands. The task of caring for the waters of these [illegible] in order to protect the bottom lands from overflow [illegible]ents many interesting problems. The most difficult [illegible]e is to convince owners, utterly devoid of experience [illegible]ain-age and ignorant of the benefits to be derived [illegible]om, that a judicious expenditure of hard earned [illegible]s in drainage improvements is a wise method of [illegible]ure. One of the large creeks was improved six or s[illegible]ears ago at a cost of about $20,000. Bay Creek, t[illegible]rgest one coming into the District (having a total [illegible]h of 130 miles), will make a start this year by [illegible]ding about $26,000 in dredging. A similar work [illegible]ilizer Creek is pending in the courts and still o[illegible]are talked of.

Much could be written concerning deposits of [illegible]ment from the creeks, in some instances burying two [illegible]three sets of fence posts; of the losses caused by flo[illegible]when the levee gave way; of the peculiar character[illegible]s of alluvial soils where streams, with banks that are [illegible]to 1 or less steep, grow narrower with each successive [illegible]het; of interesting fights with flood waters; and of the [illegible]rict dredge, which is the only dredge extant with a g[illegible]gine suction pump.

*Chief Engineer of the Sny Island Levee Drainage District, Quincy, Ill.

THE BARTON EAST DRAINAGE SYSTEM, NEBRASKA.

By L. G. HICKS.*

This drainage system is on the estate of Mr. Guy C. Barton at Gilmore, Neb., eight miles south of Omaha. There are about 600 acres in the estate, and the drainage system is south of the Union Pacific Ry., on bottom land lying in the valley of the Papillion River. The soil is a very rich black loam, the washings from the surrounding hills lying to the north and south.

This field is subject at various times of the year to overflows from Mud Creek, a tributary to the Papillion River, and owing to the contour of the ground, a quantity of these flood waters were always left standing on the field after each rise of the creek. This excess of water on this very rich soil caused it to "sour" and during the summer months it was impossible to drive a team across the field on account of the soft nature of the ground. Crop after crop of corn was planted and each would get a good start, but would be destroyed later by the excess flood water that would stand on the ground after each flood. At last the field was given over to pasture, but it was found that the ordinary pasture grasses would not live on this wet sour soil, and for the past eight or nine years the only crops have been yellow dock weeds and crawfish. I have found in eastern Nebraska that one of the surest signs of needed drainage is the growth in a field of these weeds and the presence of crawfish in the soil.

In the early part of 1905, surveys were made and plans prepared for drainage systems for two of the low tracts of land in the estate. The boundary lines of each field were given out, and along each side, at intervals of 100 ft., were placed 3-ft. laths with a small cheesecloth pennant attached, red and yellow at alternate stations. From each 100-ft. station on the north side, connecting lines were run to the opposite side, and small stakes, consisting of one-third of a 3-ft. lath, were driven at 100 ft. intervals. These connecting lines were designated A, B, C, etc., and each stake was plainly marked A-1, A-2, or B-1, B-2; in this manner the fields were divided into 100-ft. squares with a stake at each corner.

A permanent bench mark, called No. 1, was set at a convenient place for future use and an elevation of 100 ft. assumed. From this No. 1 bench levels were run with an 18-in. Gurley level around the field, and other permanent bench marks set, to be used to check field levels later. After completing the circuit around the field, a reverse line was run and all of the bench marks checked. After establishing these bench marks, the elevations of the ground at the corner of each 100-ft. square were taken, two rodmen being employed, one going up one connecting line and the other up the one next to it, each being careful to keep his end laths with their colored pennants in line, so as not to get confused as to stakes. From field No. 1, in which the starting bench mark was located, a line of levels was carried some distance to field No. 2, and the same procedure gone through there.

The field force on this topographical work consisted of the engineer and two assistants. On the level work, two rodmen were employed, this being found more economical than the usual manner of having only one rodman. One Philadelphia self-reading rod and one home manufactured rod were used. This home-made rod was graduated as described and illustrated in Mr. Elliot's book on land drainage. All rod readings were taken to the nearest 0.1 ft. on ground elevations.

After the completion of the field work, the notes were plotted to a scale of 100 ft. to the inch, and contours drawn for each difference in elevation of 0.2 ft. On these contour maps were planned and drawn the proposed system of drainage, and system No. 1, called the Barton East Drainage System, was laid out and constructed during the year 1905. This comprises an area of 75 acres.

After due consideration of other systems, the g[illegible]iron

*Civil Engineer, Board of Trade Building, Omaha, Neb.

system of laying out the tile ditches was adopted, with laterals cutting the contours as nearly at right angles as possible. All laterals were spaced 70 ft. apart, with the exception of two short laterals on the south side, which were spaced 35 ft. apart. The average depth of ditches was 3 ft. A grade of 2½ ins. per 100 ft. was determined for this main tile; the grades of the laterals were from ½ ins. to ½-in. per 100 ft., according to the lay of the land. On two of the south laterals, where the ground rose adverse to the grade line, the upper end of the ditch had a depth of only 22 ins., which is a little too shallow.

In laying out the system a field force of three men was employed, consisting of the engineer and two assistants. Stakes were set at each 100-ft. station, and also at each junction of a lateral with the main. The stakes were of soft pine, 1 in. thick, 2 ins. wide and 24 ins. long. All stakes were lined in with the transit and the side nearest the ditch put on line. This was done so that offsets could be measured more easily. (Fig. 1.) The stakes were driven until their tops were exactly half a foot above the surface of the ground, and were marked on the front with the station number; on the reverse side was put the cut from top of stake to grade, in feet and inches. After all stakes were set, levels were run and a rod reading taken at each stake, the rod being held on the top of the stake. Profiles were plotted, the ground surface being shown half a foot lower than the stake elevations. On these profiles were drawn the grade lines and all cuts figured therefrom.

In starting a ditch the first operation was to stretch a wire on the ground at the proper offset from inside face of each stake, to be used in getting the ditch straight. A man then went along with a skeleton spade and took up the sod and some 8 or 10 ins. of ditch. After him came a second man with the same kind of a spade, who took up the balance, down to within 5 or 6 ins. of the bottom grade line. The last man took up this bench and scraped the bottom with the tile spoon, testing for grade every few feet. This last man set the gage and wire and measured all offsets.

The spades used were of the skeleton variety, it being found impossible to keep any other kind of a spade clean. The only trouble with these skeleton spades was that as a rule they were not made strong enough in the shoulder. Several were broken at this point, but it will be only fair to state that this might have been caused more by the manner in which the broken tools had been used, rather than to a weakness in the steel itself. It was found that men unaccustomed to the use of this character of spade would invariably try to take too much depth of earth on the tool.

The tile spoons used were of two sizes, three and four inches. These spoons were used exclusively to scrape bottom of ditches, and as long as water was found in the ditches, they cleaned themselves very satisfactorily. In half wet materials they proved very disagreeable to clean, however. The user of one of these spoons had to learn the peculiar twist to give the tool to free it from its load after lifting it above ditch, and unless this twist was given the stuff would always cling. These spoons leave a concave surface for the bottom of the ditch, in which the tiles rest securely, and preventing lateral displacement when tamping. The man using the spoon stood on the last bench in the ditch and spaded out some 4 or 5 ft. and would then clean the bottom with the spoon, drawing the tool towards himself.

The grade for the bottom of the ditches was obtained by the line and gage method. A light copper wire was stretched from one station to the other, the smaller cut was subtracted from the larger and the wire raised that amount above the lowest stake. The wire was then pulled taut and held firmly by special iron pins, as shown in Fig. 2. The wire was now parallel to the proposed grade line, and the extension gage was set for the proper cut, and clamped. A steel square was provided so that the gage arm could be tested frequently. All cuts were marked on stakes in feet and inches, so that the ordinary two-foot rule could be used in making measurements.

For 3-in. and 4-in. tile, at depths from 3 ft. to 4 ft. the ditch was cut 11 ins. wide. For 6-in. and 8-in. tile, the ditch was made 13 ins. wide for the same depths. For greater depths, more width was given. The soil through which the ditches were cut was so interwoven with roots, that no caving of any sort occurred.

After some 50 or 60 ft. of ditch had been graded ready for tile, the man taking up the top would go back and lay tile up to the breast, plugging the end tile with a piece of board to keep out all grass, twigs and dirt. It was found that a man, after a little experience, could lay 100 ft. of 3-in. to 6-in. tile in ditches from 3 to 4½ ft. deep, tamp a small amount of dirt around the sides of tile and plug all cracks that appeared too large with pieces of broken tile, in 15 minutes. The tile used was of the red, hard burned variety and was uniformly straight and true, very little turning being necessary to bring the edges together with a close joint. The man put the pipe in place with a tile hook, being a long pole with a horizontal arm at the lower end.

Considerable water was found in the ditches, but caused no serious inconvenience; in fact the man taking up the last bench and grading the bottom preferred to see it, as it made it easier to clean the spoon, and indicated, by rippling, whenever a slight hump was left in the grade. The outlet of the main was protected by a white oak box, securely held in place by four cedar posts.

Between six and seven rods of tile laid, or about 200 ft. of top per day per man, was considered a good day's work. Men were paid $1.50 and board. Each day the foreman sent in a report card showing the number of feet of ditch opened, number of feet of each size tile laid, and number of elbows placed. After the tile was laid and inspected, two men with a team and plow backfilled the ditches, taking care to see that dirt packed in solidly and that it did not arch.

The cost per acre was $22.81. Last year the yield per acre of corn was 90 bushels, this crop more than paying for the drainage system. The engineering work, the inspection, hiring of men, etc., was done by the writer.

FIG. 2. METHOD OF USING EXTENSION GAGE AND WIRE FOR OBTAINING THE CORRECT GRADE OF BOTTOM OF DITCH FOR TILE DRAINS.

STEEL MAKING IN ELECTRIC INDUCTION FURNACES *

In a lecture on the above subject, delivered before the Sheffield Society of Engineers and Metallurgists, Mr. J. Harden spoke in part as follows, regarding the electric induction furnace:

The heat is actually produced in the charge itself, without electrodes or auxiliary heat; and thus the principal feature of the furnace is that it allows us to heat the charge up to any desired temperature without allowing it to come in contact with injurious products of combustion, such as carbon, sulphur, gases, etc. A further advantage is that the heat calories are transmitted direct to the charge without interposing any radiating surface. In other words, the furnace is simply a melting machine of great efficiency.

Every one is familiar with the frequently made assertion that the induction furnace, or, indeed, any type of electric furnace, can produce high class crucible steel from inferior materials, or even direct from iron ore, and that consequently the crucible process is doomed. These statements are most misleading. It is true that impurities can be reduced to a certain extent in this furnace by adding "physic," and that rusty scrap iron can be properly reduced. It is also true that high-class iron ore can be reduced to pig-iron by means of the induction furnace; but it must be clearly understood that for such work power must be so cheap that the process can only be successfully carried out in localities where power is to be had for next to nothing; at least, the present state of the art has not proved a commercial success. The furnace is only a modified crucible furnace; high grade raw materials, as used hitherto, must still be used for producing high-class steel. It is not commercially possible to make high-class steel from inferior material, notwithstanding laboratory assertions to the contrary; besides, the difference in the price between superior and ordinary raw materials is comparatively little compared with the price of the final product, so that this point is of minor importance. What the induction furnace will do is to permit of larger casts, cheaper and cleaner melting, and reduced labor cost.

The demand for big crucible quality ingots is increasing day after day. Die steel ingots range up to two tons weight, and the quality of steel must be perfectly regular and sound. Crank shafts and axles for motor cars necessitate the use of heavy crucible ingots. With few exceptions, the crucible steel-maker is confronted with really practical difficulties in making large ingots, taking into consideration the number of pots to be teemed and the consequent possible variation in quality. The induction furnace solves this problem for him, for it is as easy to make a two-ton charge in such a furnace as a 60-lb. charge in a crucible. The saving in cost is easily demonstrated. Most steel makers agree that the cost of melting one ton of crucible steel is between £7 ($35) and £8 ($40). Now, take the same class of steel in an induction furnace. Theoretically, one ton of steel would require 489 electrical units for melting and superheating, including "killing." Official reports from our furnace at Gysinge, Sweden, show that the furnace will give about 50% total efficiency, or, under favorable conditions, up to 55% or 58%. Thus, one ton of steel will require about 800 to 850 units. If we base our cost per unit on the most favorable terms made by the Sheffield Corporation, i. e., 0.6 of a 1d. (1.2 cts.), the cost of power for melting would be from £2 ($10) to £2 2s. 6d. ($10.62) per ton. Two men and one boy will be able to run a furnace turning out four tons in 24 hours, so that the cost for labor should not exceed 7s. 6d. ($3.62) per ton. The cost of lining, including repairs, should not exceed 2s. 6d. (62 cts.) per ton, consequently the actual cost for melting one ton of steel should be well under £3 ($15) per ton, but if the cost were to be as high as 50% of the cost of melting in crucibles, the induction furnace has a great claim for consideration by steel melters. In addition to its freedom from injurious gases, which makes it an exceptionally clean melting machine, the advantages to the men working it are very considerable. There is no lifting of heavy crucibles, and tapping is easily done by tilting the furnace. The lining is not easily destroyed, and with small repairs will last seven to eight weeks.

With regard to quality, the steel made at Gysinge has been proved to equal the best tool steel, but the quality naturally depends on the skill of the metallurgists and the purity of the raw materials employed. There is no reason whatever to doubt that the best crucible steel can be made in the induction furnace, unless it is proved that the impurities acquired by the steel melted in coke or gas heated crucibles improve the quality of the steel made in those crucibles. Tungsten and chrome steels, as well as other steel alloys, can easily be made, and nickel steel has also been successfully turned out.

Several furnaces of this type have already been erected in different parts of the world. At Gysinge, Sweden, a furnace of 175 KW. has been in operation successfully for the last five years, and two others are being constructed at Guldsmedshyttan, also in Sweden. In Germany, two furnaces are being operated, and three are being constructed, two of which are of 750 KW. In Switzerland, a furnace of 450 KW. is now being worked, while another of 200 KW. will shortly be started in Spain. In England, a furnace of 200 KW. is now at work and others are in course of construction.

*Abstract from "The Iron and Coal Trades Review."

LOCOMOTIVES OF THE 4-4-4 TYPE were suggested some months ago by Mr. D. Van Alstyne, Superintendent of Motive Power of the Northern Pacific Ry., as a development of the Atlantic of 4-4-2 type of engines with large fireboxes and consequently great weight at the rear end. In this design a four-wheeled truck under or behind the firebox would take the place of the single trailing axle or pony truck. Engines of the 4-4-4 type are in service for high-speed passenger trains on the Bavarian State Railways of Germany, these engines also having bar frames of the American type and conical or inclined "wind-splitters" fitted to the front of the smokebox, cylinder saddle, smokestack and dome. These engines were built by the J. A. Maffei Works, of Munich, Germany.

EXPERIENCE WITH VARIOUS PAVEMENTS ON STREETS WITH HEAVY GRADES.*

By C. G. ANDERSON.†

In Moline, a city of about 25,000 inhabitants, the business portion of the city lies adjacent to the banks of the Mississippi River and slopes to the north; the residence district extends back on the abrupt bluffs to the south slope and drains into Rock River. The average maximum difference in elevation between the down-town and bluff districts is 120 ft., attained in less than ¾-mile, the first five or six blocks leading up to the bluffs on very moderate slopes. The bluff line presents a very irregular contour and the watershed is cut up by numerous ravines, while only one-third of the down-town streets (north and south) are thoroughfares affording access to the bluff districts, and those streets meet the bluff line squarely. The entire question of street improvement is therefore somewhat complex, and the accompanying cut represents cross sections of streets in the city of Moline, improved in various ways under the direction of the writer and his predecessors.

THIRD ST.—This has an 8.5% grade, entirely in excavation in clay of such a character that the banks rise almost perpendicularly on both sides to a height of from 20 to 40 ft. The roadway is constructed of 6 to 8 ins. of large size macadam topped with cinders, well rolled; the gutters are of cobble stone laid so as to form the gutters without curb. The surface drainage on this street is restricted to the area of the street itself and may therefore be considered as nothing. Travel is light. The street was cut through the bluffs and improved about ten years ago. Last spring it was given a topping of 3 to 4 ins. of cinders, rolled with a 15-ton three-wheel road roller, at a cost of 7½ cts. per sq. yd. It has been subjected to drought, heavy rains and frost, and is to-day in good condition, having every appearance of being able to go through another season or two without substantial repairs.

SIXTH ST.—This is on a 10.34% grade; gutters built of cobble stone without curb. The street is built on a fill composed of clay, loam and rubbish, and the roadway exhibited marked tendencies to erode and wash out. Last spring after the annual shaping up of the roadway with the road grader it was given a topping of 4 to 6 ins. of cinders, well rolled (as above), at a cost of 7 cts. per sq. yd. The surface drainage in this case is taken care of by deep ravines on both sides of the street and is practically nothing on the street itself. Travel is light. This street has received the same exposure to weather as Third St., and is to-day in first-class condition, presenting a smooth, firm and uniform wearing surface.

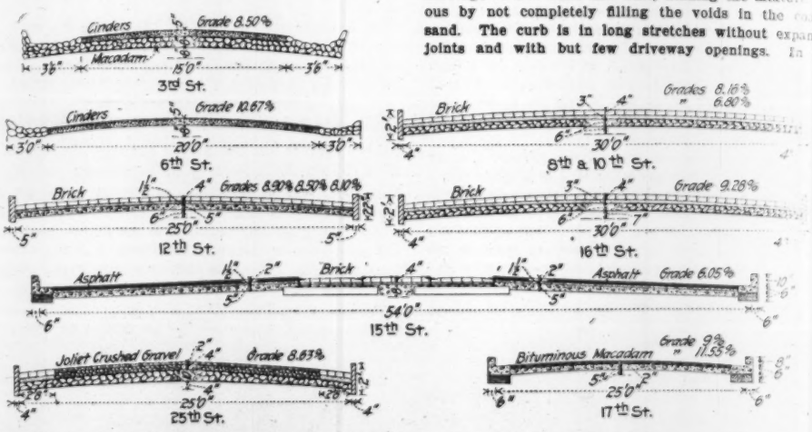
In both of these cases cinders were to be had for the hauling. Experience at other points has shown that where surface drainage, even in small amounts, has to be taken care of, cinder construction is not economical. In no event would cinders be considered as a permanent improvement, and only under conditions similar to those here outlined and where the adjacent property is of low value and unimproved is this material to be recommended as a temporary expedient.

EIGHTH ST.—This has grades of 9.76% and 8.16%. It has a brick pavement 30 ft. wide, on a 3-in. sand cushion, and 6 ins. of 2½-in. macadam; laid in 1904 at a cost of $1.50 per sq. yd. Brick of standard size with sand filler. Ohio sandstone curb 4 × 24 × 48 ins.; 48 cts. per lin. ft. Roadway excavated in good firm clay. Surface drainage taken from steep bluffs extending back about 300 ft. from the street on both sides. Travel is considerable, but consists mostly of light vehicles. The pavement was given a 6-in. crown and 8-in. curb height. The roadway shows little or no sign of wear, and the contour of the crown is well preserved. No depressions are to be found in that part of the pavement subjected to travel, but that part lying next to the curb shows settlement and slight displacement of the bricks, due in all probability to the sand cushion settling into the voids in the macadam foundation. This settlement is increased by the action of surface water seeping through the interstices between the bricks. The result is a rough and irregular gutter that exposes the bricks to intensified action by the elements and travel, and has a tendency to divert water from the gutters to the center of the roadway.

TENTH ST.—This has 1,345 ft. on 6.80% grade. Brick paving as on Eighth St., laid in 1902 at a cost of $1.47 per sq. yd. Street partly in excavation through a light unstable clay and partly on fill composed of clay, loam and rubbish, from 4 to 25 ft. in depth, the fill having been made about five years before the street was paved. Surface drainage of considerable amount comes from bluffs on either side, and also from intersecting avenues. Travel is considerable, of both heavy and light vehicles, and may be designated as medium heavy. This pavement is beginning to show the effects of chipping and abrasion, and the contour of the crown exhibits numerous depressions and upheavals ranging approximately from ¼-in. to 1-in. in depth. The gutters exhibit the same irregularities as noted on Eighth St., and to a greater extent. The curbs also display displacement in line and grade although not to an objectionable extent.

TWELFTH ST.—This has 152 ft. on 8.50% grade; 237 ft. on 7.60%, and 384 ft. on 8.90%. Brick pavement 25 ft. wide on 1½-in. sand cushion and 3-in. base of 1:3:6 concrete. Laid in the fall of 1906 at a cost of $1.70 per. sq. yd. Brick of standard size with sand filler. Curb of Berea sandstone 5 × 22 × 60 ins., 50 cts. per lin. ft. Street in excavation through a clay of variable nature; in some places firm and hard, in others springy and wet to such an extent that in dry weather it would mire the road roller. In places it was found necessary to make a considerable excavation and fill it with crushed stone before placing the concrete base. Surface drainage is heavy, coming from the adjacent bluffs and from cross streets. Travel is medium heavy. The pavement has 6-in. crown and curb 8 ins. high.

This improvement has not been down long enough to afford any valuable data, except in one particular, and that is, it shows the same tendency as other brick pavements to settlement and irregularities in the gutters. This in spite of the fact that it has an unyielding and solid base, a comparatively thin sand cushion, and was well brushed and covered with the sand filler. The only apparent explanation for this is that the sand used is river sand, which is very variable in size; one load may contain sand that will pass a No. 40 sieve and the next load contain sand that will be retained on a No. 20 sieve. In the sand cushion under a brick pavement the sand, aided by water seepage, probably undergoes a constant readjustment, the smaller particles filling the voids in the larger.



CROSS-SECTIONS SHOWING DIFFERENT STYLES OF PAVING EMPLOYED ON STREETS WITH HEAVY GRADES, AT MOLINE, ILL.

FIFTEENTH ST.—This is the main artery of travel from the business to the residence districts, and has 1,270 ft. on 6.05% grade. Asphalt pavement, of which 765 ft. is 54 ft. wide, and 505 ft. is 44 ft. wide between curbs. Two street railway tracks occupy the center of the street, and the space between rails and tracks is paved with brick on macadam base. Concrete combination curb and gutter to carry surface drainage. Constructed in 1902 at a cost of $2.10 for pavement and 50 cts. per lin. ft. for curb and gutter. Portland cement concrete base 5 ins. thick, mixed in the proportion of 1:3:6. Binder course 1½ ins. thick, composed of 1-in. clean broken stone passing a 1-in. ring and Trinidad Lake asphaltic cement, thoroughly mixed in the proportion of 1 cu. yd. of stone to 12 gals. of cement; the mixture is passed through a revolving heater. The wearing surface is 2 ins. thick, composed of 15 parts asphaltic cement, 8 parts carbonate of lime, and 77 parts sand and dust. Pavement has 8-in. crown. Concrete for curb is in proportions of 1:2:3, finished with a ½-in. surface coat of 2:3 cement mortar. Curb 6 ins. thick and 8 to 10 ins. high; gutter flags 18 ins. wide, 6 ins. thick and laid on a 6-in. cinder base. This street lies in excavation through material similar to that of Twelfth St. The bluffs rise to a height of 20 to 40 ft. above the roadway on both sides, and the street lines are held by retaining walls most of the way. This improvement was constructed during a wet season and under adverse weather conditions. Surface drainage is heavy. Travel is also heavy, most of the city's domestic fuel supply passing over this pavement.

The wearing surface is rapidly going to pieces and the city is facing the proposition of forcing the contractor to make proper repairs, with the possibility of an entire resurfacing of the street, under the terms of a 10-year guarantee. The faults in this pavement appear in various ways, sometimes in the nature of depressions 3 or 4 ins. in diameter which wear away until the concrete is exposed; sometimes these depressions have a tendency to flake and thus wear to the concrete, and at other places they exhibit a tendency to crumble. Once through to the concrete destruction is rapid, as the asphaltic mixture becomes brittle with age, and the exposed edges break away under the combined action of travel and surface water. Last spring the contractors sent a repair gang to do what repairs seemed necessary by trimming the edges of the holes and putting in patches of the surface mixture, heated in pans. No effort was made to heat the edges of the old surface and thus obtain a true bond between the new and old material. The result is that in less than a year after they were put in those patches are in plain evidence on the street. Some are now gone, and around the edges of others the destructive action goes on.

It does not appear that the failure of this pavement is due to the character of pavement adopted, but rather to imperfections in this particular job; there being short stretches where the pavement exhibits none of the signs of failure described, and seems to be in good condition. The writer is of the opinion that the failure is due to some, or all of the following causes: 1, mixture burned in heating; 2, excessive moisture in the concrete, or in the binder when top mixture was laid, causing steam to be generated, which blowing through the mixture made it porous; 3, mixture lean in asphalt; excess of or improper residuum for flux; 4, shortage of fine sand and dust, making the mixture porous by not completely filling the voids in the coarser sand. The curb is in long stretches without expansion joints and with but few driveway openings. In several places the curb is crushed by expansion, presenting an unsightly appearance and a source of weakness in the curb which would probably have been avoided by use of proper expansion joints.

SIXTEENTH ST.—This has 1,030 ft. on 9.28% grade. Brick pavement 30 ft. wide on 3-in. sand cushion and 6-in. macadam base; laid in 1902 at a cost of $1.475 per sq. yd. Brick of standard size with sand filler. Ohio sandstone curb 4 × 24 × 48 ins., 44 cts per lin. ft. Street in excavation through a light unstable clay with stratifications of firmer clay. Surface drainage is not of great quantity but reaches the street rapidly during a rain or thaw. Travel is medium heavy. The pavement has 7-in. crown and curb 8 ins. high. At the present time this pavement exhibits excessive depressions and upheavals, and the contour of the crown is ill preserved, due partly to apparent settlement of base; the destructive tendencies are especially marked along the gutters. The bricks also give evidence of chipping and wear.

We find one criticism generally applicable to all brick pavements where river sand is used for cushion and for filler, regardless of the character of base used; namely, objectionable settlement and displacement of bricks along the gutters. The writer is of the opinion that this destructive tendency can be overcome by using a cement grout filler in the gutters to a width of from 2 to 3 ft. out from the curbs.

SEVENTEENTH ST.—This has 422 ft. on 11.55% grade, 423 ft. on 9% grade. For the lack of a better designation this pavement will be called bituminous macadam. Pavement 25 ft. between curbs. Base and combined curb and gutter of Portland cement concrete similar in construction to that of asphalt pavement, in the proportions of 1:3:6 for base, and 1:2:3 (with ½-in. surface dressing of 2:3 cement mortar) for curb and gutter. Constructed in the summer of 1905 at a cost of $2.10 per sq. yd. for pavement, and 55 cts. per lin. ft. for curb and gutter. As soon as the concrete base had been tamped and before the cement had set, it was covered with clean broken limestone of such

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors at Peoria, Ill., Jan. 23, 25, 1907.

†City Engineer, Moline, Ill.

size as to pass a 2-in. ring, and be retained on a 1-in. ring. One cubic yard of this stone was spread over an area of about 72 sq. yds. After being spread, the stone was tamped into the concrete in such manner as to leave it projecting about ½-in. above the surface, giving it a rough and jagged appearance, and affording a grip or hold to the wearing surface. The 2-in. wearing surface was laid on the concrete without an intermediate course. It was composed of four sizes of crushed Wisconsin granite ranging in size from 1½ to ½-in. maximum diameter, sand ranging in size from coarse to dust, and asphaltic cement derived from California asphalt. One week's run at the mixing plant gave the following proportions by weight: Granite and sand, 92.40%; asphalt, 5.43%; residuum, 2.17%.

After the wearing surface had been raked out to proper thickness and thoroughly rolled with a 15-ton three-wheel roller, the surface was given a finish of clear asphalt, applied hot and rubbed to a thin coat, upon which was spread a ¼-in. layer of granite screenings, rolled in with the heavy roller. This last operation completely filled and sealed all interstices in the wearing surface and gave the pavement the appearance of red sand-paper. The intent of the specifications was to obtain a granite sand aggregate containing the minimum amount of voids, the function of the asphalt being in the nature of a cement to hold the particles together. The granite elements under the action of the heavy roller interlock and grip the base by means of the projecting stones.

This pavement has given complete satisfaction as to service and has not developed any defects. It is almost impenetrable with ordinary tools, turning and cutting the point of a pick, and still being far less noisy than brick pavement. The curb on this street is in long stretches and has shown the same defects as that on Fifteenth St., crushing at certain points by expansion, due to omission of expansion joints. The roadway has 5-in. crown and 8-in. curb. This improvement is in excavation through a good firm clay somewhat springy and soft in places. Surface drainage is heavy. Travel is light.

TWENTY-FIFTH ST.—This has 695 ft. on 8.63% grade. Macadam pavement 25 ft. wide between curbs. The street is cut through the hills in a light clay that stands well in bank, but washes down easily. Improvement made in 1899. Ohio sandstone curb 4 × 24 × 48 ins. at a cost of 35 cts. per lin. ft.; gutters 2 ft. 8 ins. wide, of paving brick with sand filler, on 2-in. sand cushion and 6 ins. of macadam; cost, $1.16 per lin. ft. Bottom layer of macadam 10 ins. deep at crown and 6 ins. deep at gutters, of 4-in. maximum and 2½-in. minimum diameters. Middle layer of macadam 4 ins. deep, of 2-in. maximum diameter. Top layer, 2 ins. of Joliet bank gravel crushed so as to pass a 1½-in. ring, at a cost of $1 per sq. yd. Surface drainage is not heavy, but reaches the street rapidly during rain or thaw. Travel is light. This improvement has received no substantial repairs since it was constructed, and is in fair condition. The roadway is noticeably wavy, there being numerous depressions which are not serious enough to be termed chuck-holes, the macadam having a tendency to roll out of position under the action of travel and surface water. The gutter grade line also presents a more or less wavy appearance. The roadway does not appear neat and clean because of these surface irregularities.

The prices given in the foregoing descriptions of permanent improvements include the excavation necessary to put the streets to grade, which ranges from 1 to 3 ft. in depth and which for basis of comparison may be taken at an average of 1½ ft.

The basic principle underlying the question of adopting any given type of improvement for a street is that it shall be a profitable investment for the municipality, the property owner and the traveling public. Some of the details to be considered are: initial cost, cost of maintenance, amount of travel, life of pavement, local conditions, and last but not least, what amount can the adjacent property stand in the form of special assessment. From the standpoint of initial cost, service, life, and ease of repair, present indications seem to point to the brick pavement with sand filler on a concrete base and cement-grouted gutters, as the most satisfactory and best investment for streets on heavy grades. More or less noise and slipperiness in sleety and freezing weather are the principal objections to be raised against the use of brick pavement; but with the change from hard to soft tires and from horse to power traction these objections may not prove enduring.

The asphalt pavement overcomes objections to noise and gives the street a smooth and neat appearance; but in sleety and freezing weather it is more slippery than brick. In mild weather, however, it appears to be preferred to brick, as may be readily seen on Fifteenth St., where both kinds of pavements are laid. During mild seasons of the year travel is almost exclusively outside of the car tracks on the asphalt, while during the winter it is to be found between the rails and tracks on the brick pavement. Although the asphalt abuts directly against the outside rails, and the cars used on these lines are of the heavy interurban type running on seven-minute schedule, the asphalt exhibits little or no tendency to curl up along the rails, quite contrary to what is to be seen on some of our flat-grade streets; the travel apparently keeping the surface ironed out. Another noticeable feature is that teamsters coming down hill with heavy loads have fallen into the universal habit of running with wheels of one side on the tram of the outside rail and wheels of the other side on the asphalt outside of the tracks, thus braking the wheels on the track and throwing a predominance of travel on a very narrow strip of pavement. This has resulted in a marked depression or groove in the pavement, parallel with the rail and distant therefrom the width of a wagon gear, which will ultimately prove a source of weakness in the wearing surface. It requires legislation and perpetual police enforcement to overcome this tendency on the part of teamsters.

A first-class asphalt pavement is a good general pavement, but the conditions governing its proper construction, and the practical difficulties encountered in attempting to obtain a uniform and trustworthy mixture are so great that, in the opinion of the writer it is not suitable for the improvement of streets on steep grades, where a pavement must of necessity meet with the severest conditions.

Macadam pavements are well known, from generations passed, and require no particular discussion. Under conditions of light travel and light surface drainage it affords, under careful design, a reasonably cheap, serviceable and enduring pavement, without excessive repairs.

The nearest approach to an ideal pavement for streets on heavy grades is the bituminous macadam. It affords splendid foothold for horses under all weather conditions; it is impervious to water, and has so far given no indication of disintegrating under the action of weather. It is practically noiseless, and it gives the street a neat and fairly smooth appearance. The only question that might be raised is ease of repair, and the answer to that is as yet unknown. This type of pavement may reasonably be expected to cost from 10 to 25 cts. per sq. yd. more than asphalt.

The following figures represent the writer's estimate of the life of the various improvements here discussed, assuming a street of moderately heavy traffic and a moderate amount of surface water to be cared for. Cinder surface (under ideal conditions), 1 to 3 years; macadam, 6 to 10 years; brick, 20 to 30 years; asphalt, 8 to 12 years; bituminous macadam, 10 years and over.

A REINFORCED CONCRETE SEWER SECTION.

The accompanying drawings show sections through a reinforced concrete sewer which is in course of construction in Brooklyn, N. Y. This particular section of the sewer, which is connected at its upper end to a sewer of standard brick construction, is very near the river and is designed to carry a heavy flow of storm water together with some little house sewage; hence its peculiar shaped section.

The details of the design are apparent from the drawings and need no further description. The concrete is a 1:2:4 mixture with an aggregate of either crushed stone or gravel which passes in all dimensions through a ¾-in. ring. Until the earth covering is filled upon it the concrete is kept continually damp. The 2-in. facing mortar shown as a lining is composed of a mixture of 1 part cement, ½ part sand and 1½ parts granite dust. Reinforcing rods are of the corrugated type out of high elastic limit steel and the contractors are allowed to bend them in certain specified curves if it is found impossible to make the angles shown in the drawings.

In building, the foundation is carried up approximately to the height of the brick invert, allowed to set and the brick invert then put in place. Both sides are then carried up at the same time and care is taken to form a monolithic construction by bonding together all new and old work with a 1-in. joint of 1 to 2 mortar.

As shown in the drawing, manholes are framed by the use of an I-beam grillage tied together with reinforcing rods.

The sewer was designed under the direction of Mr. Henry R. Asserson, M. Am. Soc. C. E., until recently Chief Engineer of Sewers of the Borough of Brooklyn.

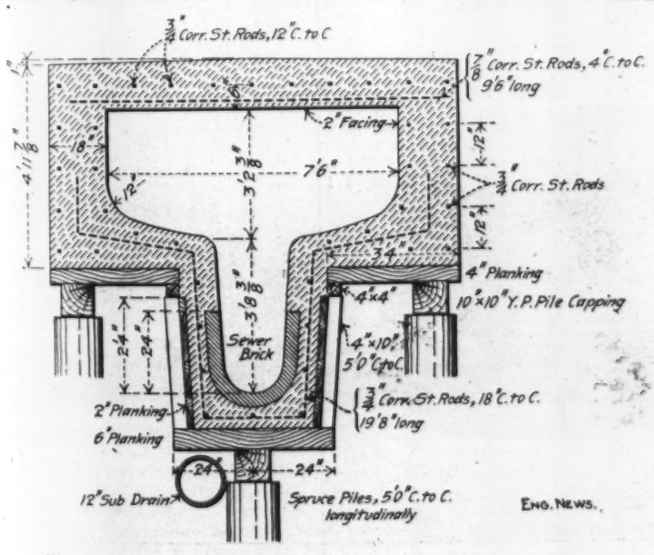


Fig. 1. Section of a Reinforced Concrete Sewer in Brooklyn, N. Y.

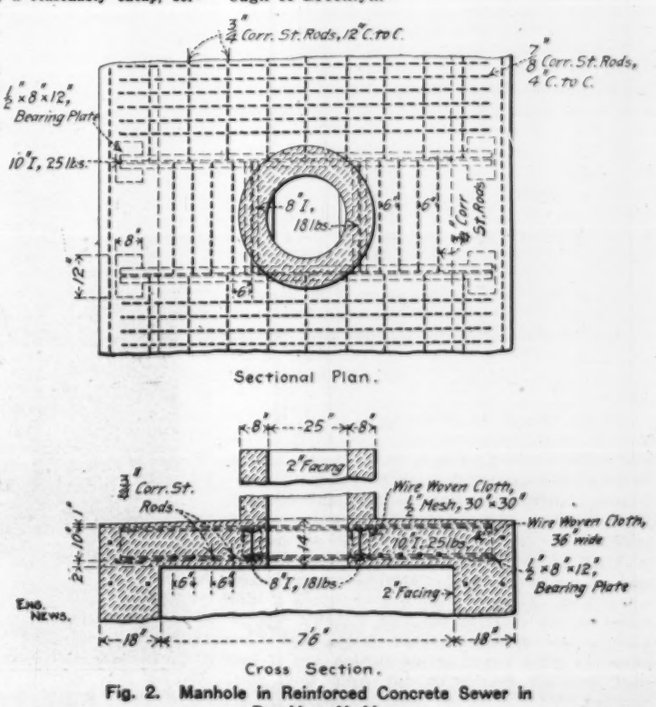


Fig. 2. Manhole in Reinforced Concrete Sewer in Brooklyn, N. Y.

A SNOW LOCOMOTIVE FOR LOGGING WORK.

In the northern forests where lumbering is in progress the logs are mainly handled in the winter, being hauled on sleds over roadways of hard packed snow and ice to points for water or rail transportation. Most of the work is done by horses, but in a number of cases locomotives or traction engines of special design are being used, the engines traveling over the snow roads and hauling enormous loads; in fact one engine can often do the work of 30 to 40 horses. One of these engines used by the Northland Pine Co. in its work on the Indian Reservation south of Leech Lake, Minn., has hauled a train of nine sleds of logs (with about 105,000 ft. of lumber) from the woods to the landing on Pine Lake, about 6½ miles. Ordinary loads are from 50,000 to 75,000 ft. of timber. The timber sleds are of the McLaren pattern, with 4-in. runners, 8 ft. c. to c., and have banks 18 ft. long, 16 × 18 ins., upon which the logs are piled.

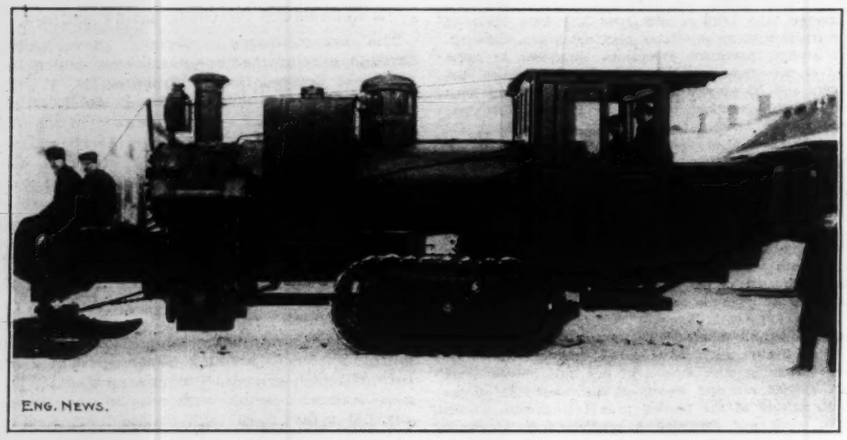


FIG. 1. LOGGING LOCOMOTIVE FOR RUNNING ON THE SNOW.
Phoenix Mfg. Co., Eau Claire, Wis., Builders.

Locomotives of this class are built by the Phoenix Mfg. Co., of Eau Claire, Wis., and one of them is shown in Fig. 1. The boiler is of the ordinary locomotive type, 3 ft. diameter and about 10 ft. long, mounted on a frame of steel channels extending the entire length of the machine and supporting the cab and coal bunker. A water tank is placed under the boiler, and in the case of the engine shown in Fig. 1 an additional tank is placed at the side, supported by a bracket on the main frame. The front end is supported on a pivoted sled forming a truck, which is controlled by chains and by means of which the engine is steered. At the rear are two heavy runners carried by a 5½-in. transverse shaft, and at each end of each runner are boxes for shafts carrying two sets of concentric sprocket wheels. The larger wheels carry the traction or tread chains which are 12 ins. wide, and fitted with heavy spurs or calks to prevent slipping. The weight of the engine is carried by the runners, wheels and chains, and the endless traveling traction chain engaging with the surface of the roadway carries the engine forward. On the smaller sprockets are tool-steel driving chains transmitting power from the shaft of the rear or main sprocket to that of the forward sprocket.

On each side of the smokebox is a pair of vertical inverted cylinders driving a shaft which has a pinion keyed upon it, between the cranks. These pinions gear with spur wheels on two longitudinal driving shafts, the rear end of each shaft having a bevel pinion which gears with a loose bevel wheel mounted on a quill on the 5½-in. shaft at the middle of the runners. At the back of the bevel wheel is attached a spur wheel which with one intermediate gear drives a spur wheel on the shaft of the rear sprocket wheels. The runners, sprockets, tread chains, and other parts are subjected to severe strains, are of cast steel, and all gearing is cut from solid steel castings.

The engines weigh about 15 tons empty, or 18 tons in working order, with coal and water. They have a speed of four to five miles an hour with loads, and make runs of four to ten miles; they are not considered economical for hauls of less than about four miles. The roads should be well graded, and are usually kept smooth by sprinkling water over them to form a surface of ice.

REPORT OF THE NEW YORK STATE WATER SUPPLY COMMISSION.

The second annual report of the New York State Water Supply Commission has recently been submitted to the legislature. The legislature of 1906 extended the powers and duties of the Commission so that it now has control over private water companies as well as municipalities, and so that it succeeds to the duties of the River Improvement Commission. So far as public water supply is concerned, the Commission has no control over either municipalities or private companies after it has approved plans for proposed new or additional works. The desirability of extending the powers of the Commission so that it may aid in preventing the pollution of public water supplies is pointed out in the report. The Commission states that only a few of the municipalities or private companies of the State "make regular tests to detect possible contamination of the water," the usual practice of both being "to delay action until diseases referable to the water supply have been general in the community" before making either [illegible] sections or analyses.

The River Improvement Commission, the [illegible]ork of which has been transferred to the Sta[illegible]ater Supply Commission, was given power to [illegible]de, on petition from municipalities or ripari[illegible]wners, whether or not the restricted or unre[illegible]ted flow of any stream was a menace to th[illegible]blic health and safety. In case the Commis[illegible] decided that the interference of the St[illegible] was warranted, then the Commission was in[illegible]cted to make maps, plans and estimates for n[illegible]ary stream improvements, and, if legislative a[illegible]oval was secured, to carry out the improveme[illegible] and assess the cost upon property benefited. The State Water Supply Commission is now e[illegible]ged in flood prevention work on Canaseraga Creek. This stream flows from Dansville to Mt. [illegible]ris, about 15 miles, and has built up a bed which in many places is higher than the adjace[illegible]land. This leads to overflows and to stagnant [illegible]ater. The creek channel will be straightened, shortening its course by some 4 miles; it will also be deepened and widened, and ditches will be constructed to carry off stagnant water. The work is under the direct charge of Mr. Walter McCulloh.

The Commission has had under consideration the improvement of the Raquette River and also the Upper Hudson. The improvement of streams is beset with troublesome questions, owing to the fact that the apportionment of the cost cannot be made until the total cost is known, and also to some questions regarding the temporary provision of funds.

The Commission suggests that some public body should be authorized to supervise the construction of new dams throughout the State, and also the repair of such old dams as have become unsafe or are causing unsanitary conditions.

On the broad phases of reservoir construction for flood prevention and the provision and value of water power facilities at State expense, the report may be quoted as follows:

> The intent and purpose of Chapter 734 of the Laws of 1904, as expressed therein, is to protect the public health and safety by regulating the flow of rivers and water courses, but it is obvious that under the statute it is especially sought to improve the water powers along streams whose waters it is desired to store and regulate at the expense of the property benefited. The direct damage caused by floods in this state in a single year, according to the statistics reported by the State Water Storage Commission, has aggregated more than $3,000,000, besides the loss of life, physical and mental suffering, impairment of health due to resulting unsanitary conditions, and the damage arising from interruption of public and private business, none of which could be assessed, computed or compensated.
>
> Consideration of the problem of so regulating the flow of rivers as to reduce this menace makes clear the fact

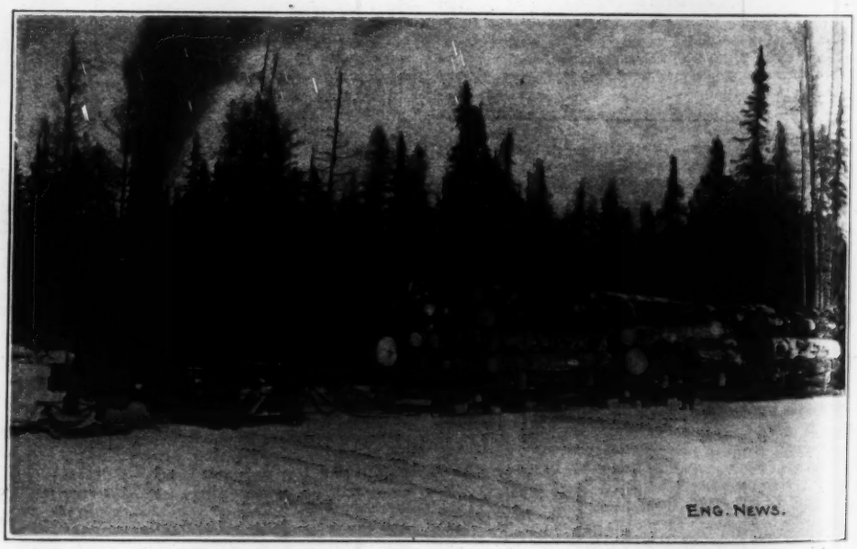


FIG. 2. VIEW OF LOGGING LOCOMOTIVE WITH TRAIN OF LOADED SLEDS.

that is the minds of many it can best be done by storing up the flood waters, thereby making it possible to prevent the annual or occasional overflow, which brings about the conditions dangerous to health and property. It is submitted that such overflows have been endured for years without appearing a matter of serious import to the state, but that fact does not indicae that it deserves no consideration.

The storage of flood waters can only be accomplished by building storage dams at favorable reservoir sites and at a large outlay of money. The reservoirs once built, however, if properly located might so control the flood waters of the rivers of this state as not only to minimize the danger to public health and safety, but to make them a constant source of advantage to riparian owners and to the state.

The law now provides that under certain conditions storage reservoirs may be built and the cost thereof assessed upon the city, town, village and individuals benefited.

The study made by this commission of the water storage question since assuming the powers and duties of the River Improvement Commission, has led it to put a high estimate on the commercial value of the rivers and streams of this state. The commission is convinced that it is practicable to build storage reservoirs, as already indicated, on streams and at places that will not conflict with the provisions of the constitution for the protection of the state forest preserves, which will regulate the flow of such streams and thus carry out the law for protecting the public health and safety. This will enable the state to sell the waters so stored to persons desiring their use and make them a permanent and most important source of additional revenue. It seems to the commission that if the law were so amended that the state could control the flow of rivers and streams requiring such control, and could regulate the price at which such waters could be sold for power purposes, a valuable and permanent source of income would be secured.

Rivers are natural sources of material wealth, since their waters furnish power that can be easily and accurately measured, and because they are constantly replenished by natural laws. Their flow is not uniform, however, and on this account many streams are unsatisfactory for power purposes, and are growing more so as the forests are cleared and fields improved. While nature has been generous, therefore, in providing our state with many and important rivers, she has also imposed a duty upon us if we would avail ourselves of these natural advantages. The problem to be solved is how to make the flow of these streams even and reliable. A proper solution will not only protect the public health and safety, but will make these streams productive of power of enormous value to the state.

The surer and better the water power the greater the manufacturing industries and the more thriving the communities depending upon them. In this country, New England was first to seize upon this evident source of advantage and develop its water power. It has to a greater extent than any other portion of our country utilized its water sources for power purposes.

It has been estimated by the State Water Storage Commission that water power in this state could be made to produce an annual profit of $18,000,000, which equals, if it does not exceed, the net profits of agriculture in this state.

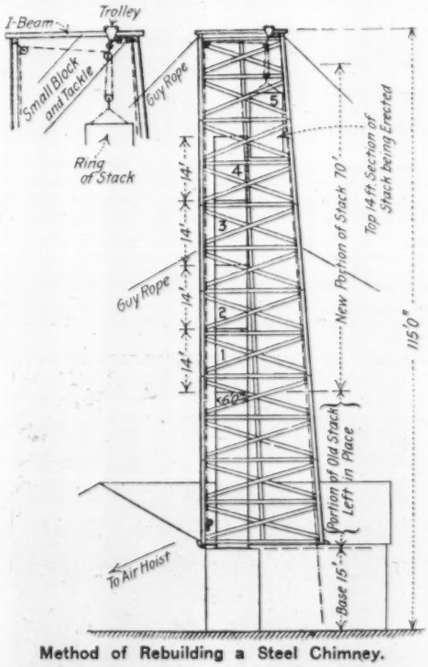
The Commission has had from its inception the services of Mr. Myron S. Falk, Assc. M. Am. Soc. C. E., as Consulting Engineer. Mr. Falk states in his report to the Commission that returns regarding public water supplies have been received from the 45 cities of the State and from 426 of the 438 incorporated villages. All of the cities and 356 of the villages have public water supplies, and no place with a population of more than 2,500 is without this service. The data collected regarding these water supplies are presented in the present or in last year's report. Utica, with a population of 62,934, is the largest city in the State supplied by a private company, and of the 36 municipalities of from 10,000 to 50,000 population, only 8 are supplied by private companies.

Mention has already been made of the lack of power on the part of the Commission to control the purity of public water supplies. Mr. Falk suggests that full authority to this end be given to the Commission, in order to terminate the anomalous condition now existing, under which the Commission "simply approves a proposed supply and then never hears of such proposed supply again." He suggests that for $10,000 a year an engineering staff could be maintained which would certify, on application, to the purity of any water supply within the State.

Another anomalous condition mentioned by Mr. Falk pertains to the water supply of Lockport. The Commission felt compelled to approve plans submitted by the city for a new water supply to be taken from the Niagara River, although the Commission knew that the character of the supply would be very unsatisfactory. This was done because it was felt that the proposed supply was very much better than the present one. Filtration was recommended by the Commission, but it has no authority to insist on the construction of filtration works.

RAPID WORK IN RECONSTRUCTING A STEEL CHIMNEY.

The chimney of the Chicago Pneumatic Tool Co.'s plant at Franklin, Pa., is a steel stack 6 ft. diameter and 100 ft. high, and had become so corroded that its renewal was necessary. When the old stack was built, it was riveted up in the shops and then raised into place in one piece, but in the recent work of renewing the chimney the construction of new buildings prevented this plan being followed. The new chimney was therefore built of 14-ft. sections having 2 × 2-in. angle iron rings at the ends to form flange joints for bolting. The plates are 3/16-in. thick in the lower portion and 1/8-in. in the upper portion. A timber tower was built, as shown in the accompanying cut, the corners being of trough form, with 2 × 8-in. planks, while the bracing was of 1 × 6-in. plank. The tower was 11½ × 23 ft. at the base and 11½ × 15 ft. at the top, the steel sections being handled



Method of Rebuilding a Steel Chimney.

within it, as shown. Across the top was placed an I-beam on which traveled a hoisting trolley, the movements of which were controlled by lines, while the hoisting cable was led to a drum operated by a pneumatic motor. The work was done by the company, and after the erection of the tower and hoist, the removal of the old and erection of the new stack was done on a Sunday, in order to avoid the necessity of shutting down the plant. We are indebted to the company for particulars of the work.

The first work was to punch three holes near the top of the stack, to receive hooks on three short chains attached to a ring suspended from the hook of the hoisting tackle. Then a section about 14-ft. long was cut off with a cold chisel and light sledge hammer; this was very quickly accomplished, as the stack was somewhat badly corroded. The work of removing the old stack was continued section by section, and the sections of the new stack were set in place in the same way. With the air-hoist attached to the windlass it did not take more than five minutes (with an average of about three minutes) to lower or raise a section after the chains had been attached. For about 30 ft. from the bottom the old stack was sufficiently sound to remain in service, and as soon as the part above this had been removed, an angle iron ring was riveted to the top of this portion. The new sections were put together with 156 bolts, ¾-in. diameter, in each flanged joint. There was no field riveting.

The work of replacement was done by four men and accomplished in almost exactly six hours, as follows: 3¼ hours for cutting and removing five 14-ft. sections of the old stack; 2¾ hours for hoisting, setting and bolting five new 14-ft. sections. It is estimated that the entire stack, 100 ft. high, could have been removed and a new one built in eight hours. The cost of the work, exclusive of the cost of the new sections of the stack, is estimated as follows: erection and removal of timber tower, $80; rigging trolley, tackle, etc., $15; removing old stack, erecting new stack and adjusting guys, $15; total, $110.

REGULATIONS FOR SEWAGE AND ROOF WATER DISPOSAL ON UNSEWERED PREMISES, HAVANA, CUBA.

Some interesting regulations providing for the construction of miniature septic tanks and of absorbing basins for rain water, pending the completion of a new sewerage system at Havana, are included in the plumbing regulations issued this year for Havana, Cuba. We are indebted to Mr. Cristino F. Cowan, Negociado de Ingenieria Sanitaria, Havana, for a copy of the regulations. The regulations, it may be added "in so far as applicable," are to apply to Santiago de las Vegas, Guanabacoa and Marianao. The portions of the regulations to which reference has been made are as follows:

Sec. 38.—Until the new sewerage system is constructed, temporary measures as those specified in Secs. 39. to 43 will be enforced.

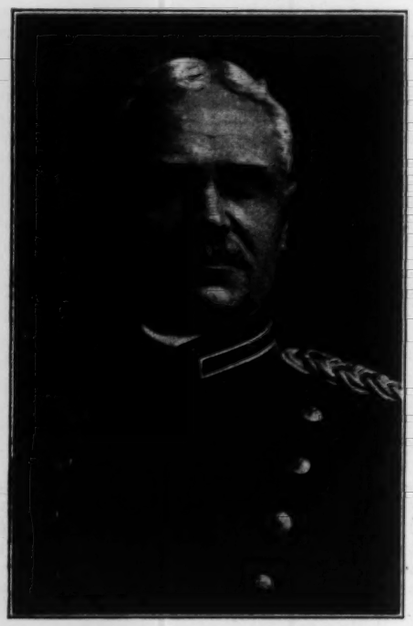
Sec. 39.—Where houses are at present directly connected to the sewer, and new closets installed, a Fosa Mouras will be constructed to serve as a septic tank before discharging the sewage into the street sewer. The Fosa Mouras shall be constructed of brick, side walls 8 ins. thick, bottom one brick thick, and plastered on the inside and bottom with cement mortar, proportion 1 to 2. Four sizes of Fosas Mouras will be used; the first, called "small," 1.20 m. in diameter and 1.30 m. deep; the second, called "medium," 1.50 m. in diameter and 1.30 m. deep; the third, called "large," 1.80 m. in diameter and 1.50 m. deep; and the fourth, called "maximum," 2.50 m. in diameter and 2 m. deep. [1 m. = 39.37 ins.] The lack of space in open areas or patios, or the difference between grades of street and house yard, will justify the omission of said Fosa Mouras.

Sec. 40.—The Fosa Mouras shall be circularly sectioned or of rectangular shape with smoothed angles at the intersection of lines; but should there be lack of sufficient open space in the "patio" it shall be constructed oval-shaped with the corresponding sizes. The inlet pipe must be at least 20 to 30 cm. above the outlet, and both conduits shall be sufficiently submerged into the vault in order to assure their self water-seal. Sizes and other details pertaining to the arrangement of bends, interior lines of pipes, etc., shall be determined in each case according to the necessities of the installation. Every Fosa Mouras constructed hereafter shall be of the type known as "Bordeaux," with a screen of brick which will make the two compartments required. Said screen will close its upper adge with the intercurrent siphon consisting of a complete bend in the shape of an inverted U with the pipe branches under the water line of receptacle. For other minor details see the drawings in the Health Department's Office. Where there is a Fosa Mouras the house sewerage trap described in Sec. 30 must be placed between it and the house fixtures. The cover of said Fosa shall be at the level of the patio, and shall be formed of wood, stone or iron, with a manhole at least 50 cm. in diameter. The cover and the manhole must be air-tight. The Fosa Mouras or one of its compartments shall not be ventilated unless especially specified by the Chief Sanitary Officer.

Sec. 41.—The rain water from roofs and courtyards may be allowed to enter the street sewer, first passing through a "poceta" for the purpose of preventing foul air from escaping from the sewer through this inlet. Such "pocetas" will be constructed as specified for Fosa Mouras, but the screen is to be arched over the outlet, so as to form an air-tight hood, and the dimensions of

the "poceta" will be 60 cm. wide and 50 cm. deep. The details of its construction are shown on the drawings on file in the office of the Chief Sanitary Officer.

Where no street sewer exists, an absorbing basin for the purpose of receiving rain water not carried to the street gutter shall be constructed. It will be 1.50 m. in diameter and 2 m. deep. The walls for a depth of 1.50 m. will be similar to those prescribed for Fosa Mouras, and at that depth shall rest upon a dry stone wall of broken stone of a size that will pass through a 4-in. mesh, and the bottom shall be composed of a



Major George W. Goethals, Senior Engineer and Chairman of the Panama Canal Commission.
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bed of similar material 50 cm. thick. These dimensions may be modified with the approval of the Chief Sanitary Officer in cases where the character of the soil renders it desirable or necessary. Where the soil is not absorbent the basin shall be used for waste from all fixtures excepting water closets, and it shall be cleaned and disinfected as often as may be necessary. These basins intended for waste water only will be smaller dimensions.

Sec. 42.—All cess-pools or privies ("pozos negros") shall be of circular section, and will be similar in all respects to the Fosa Mouras, except that no inlet and outlet pipes will be required and no screen shall be in use. The dimensions for this receptacle shall be 1.80 m. in diameter and 2 m. deep. The "excusado" (top-apartment constructed over the "pozo negro") must be constructed directly over the receptacle, and a manhole giving access to the "pozo negro" must be provided. The seat of the "excusado" must have hinged tight covers, and the discharging seat-hole will be made conically maimed at its lower end with a diameter of 20 cm. The compartment or "excusado" shall have a square opening or window of an area not less than 50 cm. square. A vent pipe to the "pozo negro" must be provided, and carried above the roof of adjoining houses as specified in another section of these Regulations.

Sec. 43.—When the use of water closets with Fosa Mouras and Absorbing Basin combinely arranged may be allowed, the pit will be dug to a depth of 50 cm. under the sea level. In higher grounds where the character of the soil permits it, the pit for the basin will be dug until a strata or vein of sufficient absorbing capacity may be found, so as to assure the complete drainage of the effluent.

Specifications for the construction of a "filtration basin" shall be made in each case according to the requirements considered by the Chief Sanitary Officer.

PORTRAITS OF ARMY ENGINEERS APPOINTED ON THE PANAMA CANAL COMMISSION.

Owing to unavoidable delays in securing photographs, we were unable to present portraits of Majors Goethals, Gaillard and Sibert, with our biographical sketches of these new appointees on the Panama Canal Commission (Engineering News, March 7, 1907, pp. 273-4). We give herewith portraits of the gentlemen named.

REPORT ON THE HUDSON RIVER ICE SUPPLY.

In view of the recent agitation over the character of the ice supply for New York City, obtained from the Hudson River, an investigation and report on the character of the ice has been made by Dr. Daniel D. Jackson, Director of Laboratories, New York Department of Water Supply, Gas and Electricity. As Mr. Jackson's report is brief and investigations of this sort are comparatively rare, we reprint the report in full herewith, including the table of analyses:

I have made inspections of the numerous sources of ice supply taken from the Hudson River and have collected and examined 25 representative samples of ice. These samples were taken from cakes representing a fair run of the ice just as it was in the act of being removed to the ice house.

In most cases analyses were made of ice taken near the top and also near the bottom of the cake. In some instances, especially when the ice showed streaks of contaminating matter, the sample was taken near the center of the cake. When samples were taken near the top of the cake no ice was chosen which represented filth or dirt incident to the harvesting, where hundreds of men and horses are employed, but ice was taken showing merely the result of "flooding" or "cultivating." This process of "flooding" the water from below over the top of the ice already formed increases the depth of the cake, but gives an ice into which are sandwiched any and all impurities of disease-producing organisms present in the water.

Impurities in the lower portion of the cake represent shallow water or contamination throughout, while samples taken from the middle of the cake which show pollution are rendered so by extensive flooding or by streaks of sewage matter throughout the cake.

The samples were carefully collected in sterilized wide-mouthed bottles and kept in the form of ice until just before analysis at the laboratory, and all examinations were made either on the same day or on the day following collection. The accompanying table gives the results of the chemical and bacteriological tests of the various samples analyzed.

Most of the ice either at the top or at the bottom of the cake showed the presence of intestinal germs. Samples, No. 8 at Saugerties, No. 10 at Catskill, and No. 17 at Coeymans, as given in the appended analyses, were of good quality. At Rhinecliff, Rondout, Athens, and Schodack Landing, the contamination in the samples examined was slight. At Germantown, Saugerties No. 7, Catskill No. 9, and Hudson the samples showed a higher degree of impurity, and the ice cut in such localities should be taken at greater distance from the shore and should be

Major David DuB. Gaillard.
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carefully inspected during its removal to insure against the use of dirty or streaked ice. At such points flooding should not be allowed.

A large amount of ice was being harvested in Catskill Creek, which would undoubtedly show a high degree of contamination, but no samples were taken from the creek, as I was requested to confine my attention to the ice taken directly from the Hudson River.

The samples taken two miles below Albany and at North Albany showed the ice to be of good quality in spots, but much of it is streaked or sandwiched with sewage matter. A comparison of Samples 18, 1[illegible] 20 strongly demonstrate this point.

These samples show a variation in adjoining [illegible]s of ice from 7 to 12,580 bacteria per c. c., and from [illegible] or 3 to at least 100 intestinal germs per 10 c. c. It [illegible]vident that ice cannot safely be used for domestic [illegible]poses which is cut between Troy and Albany or w[illegible] five miles below the latter city.

Much of the ice is so dirty in appearance [illegible] it is discarded by the ice companies, and this discar[illegible] ice, which lay in heaps outside the ice houses, was a[illegible]d to be carted away to certain local hotels.

There are numerous ice houses just below th[illegible] South Bridge at Albany, and the ice taken from these [illegible] pre-

Major William L. Sibert.
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sented by Samples Nos. 21, 22 and 23. This ice is well described by the term "solidified sewage," and much of it is being cut close to the large sewer outlets.

It is estimated that 3,500,000 tons of ice are harvested annually on the Hudson for consumption in or about Greater New York. Large amounts are also cut for use in the various towns and villages along the river.

The population of the drainage area of the Hudson Valley is not far below 700,000, and the sewage from this number of persons is discharged directly or indirectly into the Hudson River. In addition, farm and dairy drainage and surface wastes find their way eventually into the stream.

Freezing eliminates the impurities to some extent, but does not render harmless water which has been badly contaminated. It has been amply demonstrated that the germs of typhoid fever are not killed by freezing, and they have been known to live in ice for long periods of time.

There is much typhoid in the towns all along the Hudson, especially in the fall of the year, and millions of germs from the fever patients are washed by rainfall or are carried directly by means of sewers into the river. Being warmer and lighter than the river water, the greater portion of the sewage naturally floats out over the surface of the river. There is nothing to prevent some of these disease-producing elements from becoming lodged in the ice, and since it is a common practice all along the river to flood the ice extensively, it is hardly possible to escape the freezing of sewage matter into the upper portion of the cakes.

CONCLUSIONS.

The examinations and inspections which we have made prove conclusively:

That the cutting of ice anywhere on the Hudson River should be carefully regulated and strictly supervised as to flooding, general appearance, distance from the shores, and especially distance from sewer outlets and other immediate sources of contamination.

That at least certain portions of the Hudson River (notably, within five miles of the city of Albany) should be condemned for the harvesting of ice for domestic purposes.

That the cutting of such ice should be allowed only on permit from the State Board of Health showing that it is to be used solely for cooling in chemical works or for cold storage where there is absolutely no contact with food, and a single violation of the permit should forfeit all rights and subject the culprit to heavy fine.

ANALYSES OF THE HUDSON ICE SUPPLY.

Place of collection of sample.	Odor.	Name of Company.	No. bacteria per C. C.	Character of ice.
1—Schodack Landing, top of cake.	None.	American Ice Co.	2,120	Slightly contaminated.
2—Schodack Landing, bottom of cake.	None.	American Ice Co.	42	Good.
3—Middleout, top of cake.	None.	American Ice Co.	92	Good.
4—Middleout, bottom of cake.	None.	American Ice Co.	87	Slightly contaminated.
5—Germantown, top of cake.	Vegetable.	American Ice Co.	260	Good.
6—Germantown, bot. of cake.	Unpleasant.	American Ice Co.	280	Contaminated by organic matter.
7—Coxsackie, top of cake.	Earthy.	American Ice Co.	180	Contaminated.
8—Coxsackie, bottom of cake.	Vegetable.	American Ice Co.	92	Good.
9—Catskill, at dock—				
No. 1, top of cake.	None.	American Ice Co.	234	Contaml'd from Catskill Creek.
No. 2, bottom of cake.	None.	American Ice Co.	135	Good.
11—Hudson, top of cake.	Disagreeable.	Local supply	97	Contaml'd from sewage of town.
12—Hudson, bottom of cake.	None.	Local supply	24	Good.
13—Athens, top of cake.	None.	Howland & Son*.	82	Slightly contaminated.
14—Athens, bottom of cake.	None.	Howland & Son*.	184	Slightly contaminated.
15—Schodack Ldg., top cake.	Vegetable.	W. I. & C. L. Gardiner Co.*.	178	Slightly contaminated.
16—Schodack Ldg., bot. cake.	None.	W. I. & C. L. Gardiner Co.*.	37	Good.
17—Weymans, top of cake.	None.	J. N. Briggs Co. (Independent)	22	Good.
18—Albany, 2 miles below city, top of cake.	None.	American Ice Co.	14	Good.
19—Albany, bottom of cake.	None.	American Ice Co.	7	Good.
20—Albany, 2d top sample.	Disagreeable.	American Ice Co.	12,580	Bad.
21—Alb., just below So. Bdge.	Rank.	Schiffendecher Co.	13,685	Bad.
22—Alb., just below So. Bdge.	Rank.	Papian Co.	16,110	Bad.
23—Alb., just below So. Bdge.	Rank.	B. B. Lansing Co.	21,210	Bad.
24—North Alb., top of cake.	Unpleasant.	Hudson River Ice Co.†.	54	Contaminated.
25—North Alb., bot. of cake.	None.	Hudson River Ice Co.†.	6	Good.

*Sell to Foster-Scott Co. †Sell to American Ice Co.

That much of this ice is at present sold for domestic use both in Albany and in New York City and undoubtedly is the source of many cases of typhoid fever and other intestinal diseases.

THE METHOD AND APPARATUS FOR CHAINING USED BY THE TOPOGRAPHICAL BUREAU, BOROUGH OF QUEENS.

By GEORGE J. FALKINBURG.*

The monumenting of a large area for a city street system, as for example one of the boroughs of New York City, involves many nice and difficult problems, among the most important and perhaps the most difficult of which is the final chaining. To obtain results that are reliable and of permanent value requires that the work be done with a high and unvarying degree of accuracy, that the personal equation be reduced to a minimum and the results to an absolute standard.

The ordinary 50 or 100 ft. catenary chain, even with the most perfected spring balance and level attachments, cannot give an accurate measurement when the plumb-bob system of end determination is used. The temperature-adjusted base-bar apparatus is extremely clumsy and expensive and has never produced results of enough superiority to recommend its use in work of this sort.

Recognizing the limitations and defects in the various measuring devices for this work, the Topographical Bureau of the Borough of Queens has developed an apparatus for chaining which after a continuous use for over two years, under the varying topographical features in this borough, has proved uniformly accurate, reliable and fast. Primarily intended for accurate monument traversing, it was found efficient and economical for other kinds of work. Its greatest advantage is its universal adaptability. It can be used on the roughest ground with the same accuracy of results and with almost the same facility as on level country. It is simple in construction and use. An engineer in charge and four or five laborers are required.

The apparatus consists of a 100-ft. steel tape ⅝-in. wide, divided into four 25-ft. sections by brass lugs; a spring balance with ring attached to the end, into which is placed a sharp-pointed pole; three tables having a circular top of oxidized bronze about 5 ins. in diameter set on an adjustable metal tripod; an adjustable wooden triangle made so that the sides can be crossed and fastened at any desired height from 1 to 4 ft.; and a wooden standard called the center support, consisting of a vertical rod set in a wooden base, the rod being perforated by a series of holes in which is placed the nail on which the tape rests. A transit is used to give line.

The measurement is made on the slope. The difference in elevation between the ends of the tape on each application is taken by an engineer's level and rod, and the corresponding horizontal distance is computed. The work proceeds as follows: The distance between two or more points is to be measured. The transitman (an intelligent laborer can do the work satisfactorily) sets up over one of the distant points, and takes his sight on the starting point. The rear chainman holds the rear end of the chain approximately over the point so that the fore chainman may find the distance at which to set a table. He obtains line from the transit and sets the table firmly with the top approximately parallel to the slope, on line, and at the proper distance. The rear man sets a table a little back of the starting point on which to hold the end of the chain, while an assistant with a carefully shielded bob suspended from the graduation on the zero lug, directs the rear man to move the chain until the bob, and thus the zero, is exactly over the point. A man sets the support at the 50 ft. lug and under the direction of either chainman sighting along the top of his table to the one beyond, places the nail on line, and in the plane joining the table tops. In the meantime the assistant at the front end has hooked the spring balance onto the tape, and placed his pole through the ring at the end, forcing the point into the ground or holding his foot against it when on pavement. Bracing the pole against his shoulder, he applies the proper tension, determined by a previous standardization of the tape and balance, and brings the tape over the center of the table. (Fig. 2.) The rear man calling "right," the tape is snapped in the middle to overcome friction, and the fore chainman with a sharp pencil marks the table at the graduation on the 100-ft. lug. Fig. 2 shows the fore chainman marking the table. On succeeding applications the forward end proceeds in the manner just described; at the rear, however, on all applications after the first only one man is required. On coming to the table marked by the forward end the rear man adjusts the wooden triangle so that the crotch formed by the crossing of the two side pieces comes to the height of the table. To this the end of the tape is attached by means of a brass chain. (Fig. 1.) As the pull is applied the rear chainman supports the triangle with his body and one hand, moving it slightly back and forth, until, guided with his other hand, the graduation on the zero lug comes exactly to the mark on the table. He calls "right" and the chainman marks the next table. The leveling rod is held on the table and the reading recorded. The mark on the rear table is now erased and the table carried forward to be used again. The temperature is taken during each application of the tape and in its immediate vicinity. The correction is made on the total distance by taking the average temperature during the measurement.

On reaching a point whose distance is required, the plus is taken as follows: (1) If the point comes within 10 ft. of a table a horizontal measurement is made from the mark on the table with the graduated tape and the bob in the usual manner. A hand level is used to bring the tape horizontal and the bob is carefully shielded. The tape is read to thousandths, the thousandths being estimated. (2) If the plus comes more than 10 ft. from the table, the next 50 ft. measurement is made as before. After the table has been marked both ends keep "right," while a bob is plumbed over the point, and where the plumb line crosses the chain a sharp mark is made with a pencil. The mark is carefully checked. With the graduated tape the distance from the nearest lug is measured and recorded as ¾ + (distance) or ¼ — (distance) as the case may be. (3) If the measurement is to stop at the point, a table may be set under the nearest lug. The rear chainman sighting over the table tops directs the man with the balance to move

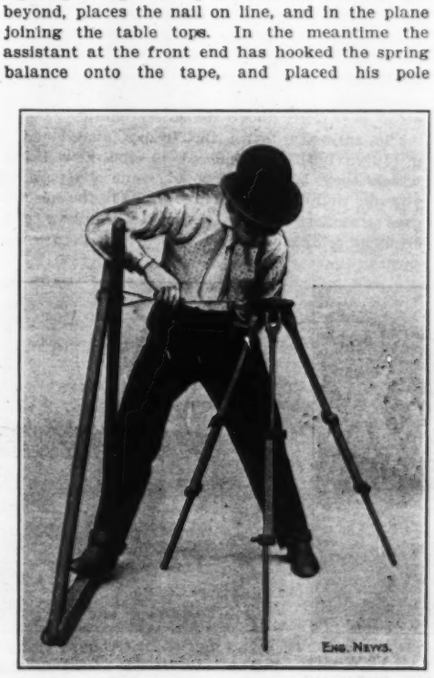

Fig. 1. Rear Chainman Holding Tape in Position.

Fig. 2. Front Chainman Marking Measurement.

ACCURATE CHAINING APPARATUS USED BY THE TOPOGRAPHICAL BUREAU, BOROUGH OF QUEENS, NEW YORK CITY.

it up or down until in the plane of the tables. Both ends giving "right," the table is marked where the graduation on the lugs strikes. A plus or minus is then taken with the tape and bob to the required point. The rod on the table is read as usual.

The difference between the rod readings gives the difference in elevation between the successive

*Topographical Draftsman, Topographical Bureau of the Borough of Queens, New York City.

HORIZONTAL EQUIVALENTS OF 100 FT. MEASUREMENTS ON SLOPE.

0.00	100.000	6.00	99.820	10.10	99.489
0.50	99.999	6.10	99.814	10.20	99.478
0.75	99.997	6.20	99.808	10.30	99.468
1.00	99.995	6.30	99.802	10.40	99.458
1.25	99.992	6.40	99.795	10.50	99.447
1.50	99.989	6.50	99.789	10.60	99.437
1.75	99.985	6.60	99.782	10.70	99.426
2.00	99.980	6.70	99.775	10.80	99.415
2.25	99.975	6.80	99.769	10.90	99.404
2.50	99.969	6.90	99.762	11.00	99.393
2.75	99.962	7.00	99.755	11.10	99.382
3.00	99.955	7.10	99.748	11.20	99.371
3.10	99.952	7.20	99.740	11.30	99.360
3.20	99.949	7.30	99.733	11.40	99.348
3.30	99.946	7.40	99.726	11.50	99.337
3.40	99.942	7.50	99.718	11.60	99.325
3.50	99.939	7.60	99.711	11.70	99.313
3.60	99.935	7.70	99.703	11.80	99.301
3.70	99.931	7.80	99.695	11.90	99.289
3.80	99.928	7.90	99.687	12.00	99.277
3.90	99.924	8.00	99.679	12.10	99.265
4.00	99.920	8.10	99.671	12.20	99.253
4.10	99.916	8.20	99.663	12.30	99.241
4.20	99.912	8.30	99.655	12.40	99.228
4.30	99.907	8.40	99.646	12.50	99.216
4.40	99.903	8.50	99.638	12.60	99.203
4.50	99.899	8.60	99.630	12.70	99.190
4.60	99.894	8.70	99.621	12.80	99.177
4.70	99.889	8.80	99.612	12.90	99.164
4.80	99.885	8.90	99.603	13.00	99.151
4.90	99.880	9.00	99.594	13.10	99.138
5.00	99.875	9.10	99.585	13.20	99.125
5.10	99.870	9.20	99.576	13.30	99.112
5.20	99.865	9.30	99.567	13.40	99.098
5.30	99.860	9.40	99.557	13.50	99.085
5.40	99.854	9.50	99.548	13.60	99.071
5.50	99.849	9.60	99.538	13.70	99.057
5.60	99.843	9.70	99.528	13.80	99.043
5.70	99.837	9.80	99.519	13.90	99.029
5.80	99.832	9.90	99.509	14.00	99.015
5.90	99.826	10.00	99.499	14.10	99.001

tables. The corresponding horizontal distance is then computed. To avoid recomputation of these distances, a table of horizontal equivalents for 100 ft: measurements on slope for differences of elevation of 0.1 ft. from 0 to 14 ft. has been computed and carried in the note book. This table accompanies this article. (Table I.)

Two independent measurements in opposite directions are made of each distance with an allowable error of 0.01 ft. in 1,000 ft.

Under ordinary conditions from 8,000 to 10,000 ft. can be measured in a day at a cost of about 0.14 cts. per ft. The work in Queens is under Mr. Robert R. Crowell, Chief Engineer, Topographical Bureau, and Mr. J. A. Wineberger, Principal Assistant Engineer in charge of monumenting.

THE LONG BRIDGE ACROSS THE POTOMAC AT WASHINGTON, D. C.

The old "Long Bridge" across the Potomac River, connecting Washington with Virginia, one of the oldest if not the very oldest relic in America of the timber Howe truss era, and certainly the best known of all that ancient band, is now being removed. The accompanying photographs and brief description will be of interest to many of our readers, the majority of whom have doubtless more than once crossed it to and from the South.

The Long Bridge was built in 1809 by the Washington Bridge Co. as a toll bridge. This structure was destroyed in 1861 by a freshet. It was rebuilt by the government in 1834, but partially destroyed by the sudden breaking up of the ice in 1840. In 1843 it was again opened to travel. In 1870 the Baltimore and Potomac R. R. Co. was authorized to take over the bridge for their own use, keeping it in repair and maintaining a roadway on one side, and it has remained under this control until the present time.

At the time of the inception of the project for reclamation of the Potomac flats (1881) the total length of what was known as the "Long Bridge" was 4,677 ft. and consisted of three sections; a wooden bridge 700 ft. long resting on masonry piers across the upper end of the Washington channel; an earth fill 1,980 ft. long between masonry retaining walls across the partially submerged flats; the bridge proper 2,000 ft. long across the main channel of the Potomac, consisting of 13 fixed spans 135 ft. in the clear and a pivot span 182 ft. long with two 70-ft. openings, one only, however, being open to navigation. After the reclamation of the flats the wooden bridge over the Washington channel was replaced by a long fill and a two-span plate girder.

With the exception of the draw, the bridge consisted of three lines of trusses, the two south ones supporting the railroad being reinforced with timber arches, as shown in Fig. 1, which is taken from the south side at the Washington end. The extreme width out to out of trusses was 40 ft. 5 ins. The roadway was 19 ft. 2 ins. in the clear, with no sidewalk. The clear distance between trusses supporting the single track was 13 ft. 2 ins. The masonry piers were of soft sandstone founded on piles and a timber grillage at low tide level and heavily riprapped, the riprap reducing the cross section of the river by about one-third. The axes of the piers were not parallel to the current, and the lower chord was but 10.3 ft. above mean low tide; also the draw was not placed in the proper position for the channel.

All these things caused the bridge to be a serious obstruction to the tidal flow, requiring constant dredging in order to maintain a navigable channel of 20 ft. at low tide. During the years 1870, 1877, 1881 and 1889, freshets did more or less damage to the bridge. In 1881 the ice banked up at the bridge, the water level standing 2 ft. above the lower chord. The gages above and below showed plainly the obstruction caused by this condition. In 1889 the water stood over 2 ft. above the lower chord.

The railways using the bridge abandoned it in July, 1904, and moved to the new bridge which they had constructed some distance up stream, and in the spring of 1906 the electric cars transferred their tracks to the new government bridge, also near by. The structure was closed for traffic in the fall of 1906, and work started toward its destruction. The Assistant Secretary of War has granted a permit to W. H. Johnson, Jr., of Philadelphia, to remove the bridge, in accordance with his contract with the Pennsylvania R. R., from which he bought the bridge for $175. Mr. Johnson will begin the work at once, so as to complete it by July 1. The bridge will be taken town in sections, piles being driven under it to support the scaffolding for the work. The work of removal will begin at the D... end of the bridge and the material will be removed to the Virginia side. The piers will be removed by the use of barges.

We are indebted for the information and photographs herewith presented to Mr. T. C. J... Jr., M. Am. Soc. C. E. The photographs were taken by Mr. G. V. Rector.

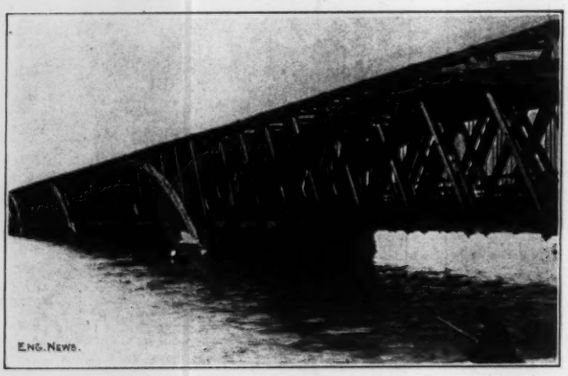

FIG. 1. THE LONG BRIDGE ACROSS THE POTOMAC AT WASHINGTON. VIEW FROM WASHINGTON END, SHOWING REINFORCING ARCHES ON RAILWAY TRUSSES.

FIG. 2. VIEW OF LONG BRIDGE AT WASHINGTON FROM VIRGINIA SIDE. PIERS FOR RAILWAY BRIDGE ON LEFT.

DUPLEX STEEL TIES FOR RAIL JOINTS.

A double steel tie for use at rail joints, designed to support the rail ends and also to prevent creeping of the rails, is described in the February number of the "Bulletin" of the International Railway Congress Association. It resembles two cross ties of the usual English section employed in Europe, connected under the rails by bridge pieces of the same section; it is all formed in one piece. At first the bridge pieces were sometimes level with and sometimes lower than the tops of the ties, but the former practice is now preferred, so as to give a continuous support to the rails. The bridge pieces and the ends of the ties are bent in a press to give the rails an inward inclination of 1 in 20, as is customary in European practice. The rails are bolted to the ties proper in the usual way, no additional fastenings being used. When a trial order was given by the St. Gothard Ry. in 1903, it was required that there should be a small depression or groove in the middle of the bridge piece, immediately under the joint, so that the rail flanges would not cut into the tie. It has since been stated by the engineers that this depression affected the wear of the splice bars, and that in future they would have the ties with a smooth top, so that the ends of the rails may be supported for their entire length.

This double tie has been in use since 1898, and is being tried experimentally on a number of lines in Germany which carry very heavy traffic. A trial section at Mayence was laid in 1901, and after five years service under heavy traffic no defects were visible, and the rails and splice bars showed no wear. Others laid near a station at Berlin, where the trains often had the brakes applied, showed that after three years the creeping had not exceeded $^5/_{16}$ to $^9/_{16}$-in.; during this time the ballast on this section had been tamped at the intermediate ties, but not at all at the joint ties. In other cases the absence of creeping was specially noted. It is stated that the total increase in cost from putting in the double tie is about $1.50, but that this is more than gained in the first year's service by the saving in maintenance of track, to say nothing of an indeterminate saving in maintenance of rolling stock due to the smooth and steady riding of the joints.

At the end of 1905, there were 7,370 of these joint ties in use; 4,040 on narrow gage and 3,330 on standard gage lines, ranging from light colonial lines and tramways to heavy main lines. The patents are owned by Breuer, Schumacher & Co., of Kalk, near Cologne, Germany.

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The ruinous effect upon street pavements of the continual uptearing to which they are subjected, to gain access to underground pipes, has often been commented upon in these columns and made the text for a discussion of the advisability of constructing subways, or pipe galleries, in the busiest streets of our larger cities. Elsewhere in this issue there will be found a somewhat lengthy article describing pipe subways in a number of foreign cities.

Through an unfortunate combination of circumstances an unusual opportunity to provide a portion of New York with pipe subways was lost during the construction of the rapid transit subway system. We are pleased to be able to state that pipe subways are being included in all the plans for extensions now being prepared.

While America has very little to show in the way of pipe subways, it may be noted that *conduits* for electrical wires are common. In the Introduction to "The Municipal Year Book" for 1902, it is stated that of 1,524 places having 3,000 population or over, no less than 232 had some of their wires underground. Of the 78 cities with 50,000 population and upwards by the last census, all but 7 cities had some wires underground; while the same was true of 105 of the 135 cities of 30,000 population and over. At the close of 1906, the Bell telephone companies in the United States reported that 54% of their wire mileage was underground. In this respect the telephone companies are far in the lead of other private corporations. In a number of American cities, including New York and Baltimore, practically all the electric wires are underground, at least in the most thickly settled portions of the cities. It is to be hoped that the practice will continue and that it will be extended, as opportunity is offered, so as to include pipes as well. Practicable opportunities of this sort may not often occur, but when, as in the case of the New York rapid transit system, they do occur they should be made the most of, as is to be done hereafter in New York.

It is unfortunate that the report of the committee of Pennsylvania R. R. officials which investigated the recent derailment at Mineral Point, Pa., appears to cast some degree of discredit on steel ties. We say "appears," because it is admitted that the steel ties had nothing to do with causing the derailment. As to the expressed opinion that less injury to the track would have resulted if wooden ties had been in use, it is important to observe that this is nothing more than opinion, and that opinion on the subject of possible relative damage in railway accidents is of little or no value.

The results of railway accidents follow no laws. In one case a derailed car may run along the track and do little damage, while in another case, under apparently precisely similar conditions, it will tear up the track and smash the ties, or perhaps break spikes and splice-bolts, for a considerable distance. Yet upon the mere suppositional opinion that the damage to the track was more severe than would have been the case with wooden ties, the committee recommended the removal of the steel ties. The general impression was thus created—and this is the unfortunate part of the matter—that steel ties make railway track less safe for high-speed traffic. In view of the fact that the steel tie has been struggling hard for recognition in this country, after the experience with it in Europe has been very satisfactory, and in view of the great importance of developing useful substitutes for the conventional wooden tie, this erroneous impression threatens to work injury to a promising technical development in railway practice.

A matter more easily overlooked than the suppositional nature of the opinion that less damage would have resulted on a wood-tie track, is the fact that the recommendation to remove the steel ties does not logically follow from the opinion. The function of track is to carry trains safely on the rails, not to possess maximum resistance to the impact of derailed trains. If track composed of rails bolted to ties (as with steel ties) is superior to track with rails spiked to wooden ties—as may perhaps be found to be the case with proper design and construction—it is questionable whether possible liability of greater injury to the steel-tie track in case of derailment would be a good argument against its use.

In looking over a book which recently came into our hands we find a passage that merits being quoted and emphasized each year, in this season of the near approach of Spring, with the resumption of road work. The passage occurs in Prof. Ira O. Baker's circular, "Drainage of Earth Roads," issued by the University of Illinois Experiment Station,* and reads thus:

> The most important work in maintaining an earth road is to keep the surface smooth so that the rain water will flow quickly into the side ditches. If the surface of the roadway is properly formed and kept smooth, the water will be shed into the side ditches and do comparatively little harm; but if it remains upon the surface it will be absorbed and convert the road into mud. If all ruts, depressions, and mud holes are not filled as soon as they appear, they will retain the water upon the surface, to be removed only by gradually soaking into the road-bed and by slowly evaporating; and each passing wheel or hoof will help to destroy the road.

More money is spent each year on the maintenance or current repair of the earth roads of this country than is spent on the Panama Canal. The average efficiency of this expenditure is perhaps lower than the mean efficiency of all the moneys spent on the Panama Canal ever since the first conception of the project; that is to say, the tangible result per dollar spent is less. In making this statement we do not have in mind the question of whether or not the improvement of earth roads is of public utility, but we refer only to the actual result in road improvement as compared with the result that might be obtained with the same money if skilfully administered. We are aware that many persons hold that money spent on earth roads is money wasted. Our own view is quite the opposite, namely, that the value of good earth roads to the people as a whole is almost inestimable and far exceeds any value which may be calculated as savings in haulage cost. This view, of course, would still further emphasize the desirability of renewed attention to principles of road-repair economics. But for the present purpose we need to have recourse only the much narrower and more strictly engineering argument that the enormous sums spent on earth roads should be spent with proper attention to engineering principle, to bring about a maximum of actual result. We suggest the above quotation as one of the most valuable elementary principles which lead to this end.

*The first portion of this Station's publications has just been issued in a bound volume of 450 pages, for special distribution.

The engineering experiment station established by the State of Illinois at the State University, from whose circular we quoted above, represents a distinctly new development. The station has been in existence now for three years, and, as noted, a fair-sized volume of publications has been issued. The work published includes investigations in the field of reinforced concrete, studies of high-speed tool steel, experiments to determine the collapsing pressure of tubes, studies of the strength of railway spikes and the like. As a whole it has contributed materially to the advance of engineering knowledge. It seems that, broadly speaking, the work done is of the same kind as is done in the engineering laboratories of other technical colleges. The idea of a State experiment station, however, has far wider possibilities. Somewhat analagous to an office of weights and measures, it can furnish a public court of appeal, impartial, well-equipped with training and machinery, where tests may be made and technical questions that come before private or public parties, too difficult to be solved on the spot, may be studied or passed upon. This function can be made a most important one, we believe. Its development, of course, would require time, patience and continued contribution of State moneys. The start made by Illinois toward the upbuilding of such an institution is worthy of high commendation. One is led to hope that other States will recognize that their State universities may easily develop a similar station, and that ultimately each one of our constituent commonwealths will afford its people a technical reference center of this kind.

The opponents of municipal ownership the world over are much elated by the overwhelming defeat of the Progressive party in the London County Council election on March 2. While the municipal ownership programme of the party doubtless contributed very materially to its defeat, it should be understood that the attitude of the party on other municipal problems was at least equally responsible. As some of our readers know, municipal activities in Great Britain far exceed anything more than dreamed of in America. The opponents of municipal trading (as municipal ownership and allied activities are called in England) have for some years been conducting a vigorous campaign against the rapid municipalization of practically all the public services operated under municipal franchises in this country, and at the same time they have been protesting against municipal councils embarking in housing schemes, public baths, markets, milk depots, and many other enterprises, actual or projected. It has been alleged that these practices on the part of municipal councils were rapidly throttling individual enterprise, were creating a vast army of municipal employees at the will of the councils, and were rolling up a most alarming municipal indebtedness. The agitation regarding the rapid increase in indebtedness, and the claim that the municipal tax rates would soon be raised to such a point as virtually to confiscate private property, were probably the most effective of the arguments that were raised in the recent campaign waged in behalf of the so-called Moderates and against the Progressives, both as represented in the London County Council election a few days past and in the election last fall of Council representatives in the 28 boroughs within the administrative area of the County Council.

While the result of these elections may put a check on some enterprises quite outside of what we here understand by municipal ownership, and may result in the temporary if not permanent elimination of the Works Department of the London County Council (under which a large amount of construction work has been done by day labor instead of the contract system), it seems very unlikely that the great municipal ownership movement which has been sweeping onward in Great Britain for some 30 years will be retarded to any great extent. Such retardation as there is will

doubtless most affect tramways or street railway systems, and, next to this, electric lighting. Gas works and water-works, which have for so many years been extensively and most efficiently operated by British municipalities, will doubtless continue to be so operated, and the number of such plants will continue to increase.

Still less does it seem likely that the results of the London elections will retard municipal ownership in the United States and Canada—although unquestionably this defeat of municipal ownership advocates abroad will afford no little ammunition for the opponents of municipal ownership in this country. A far more effective check to municipal ownership in the United States than any arguments based on happenings abroad would be a radical change of attitude of public service corporations in this country. If such corporations wish to continue in the enjoyment of their privileges, they must encourage rather than oppose public control of their capitalization and of their service charges, and must open their accounts to the public or its official representatives to a sufficient extent to show that the rates they charge do not provide more than a reasonable return on the actual amount of properly invested capital.

It would be for the interest of both municipalities and private corporations to see that their accounting systems are reformed so as to exhibit clearly construction costs, operating and capital charges, all on a uniform and comparable basis. No end of foolish talk on both sides of the municipal ownership question would be stopped if actual and reliable figures were the basis of discussion instead of guesswork figures or figures based on doctored accounts. Much light would also be thrown upon the municipal ownership question if, when discussing the effect of municipal ownership upon the tax rate of a community, it was known what sums the taxpayers would be required to pay to private corporations and contractors for rendering the same service in case the enterprises in question were not under municipal ownership. This is a phase of the subject that has been almost entirely overlooked by both the advocates and opponents of municipal ownership. Residents of cities must depend upon other people for a large number and variety of services. To take an example outside of the municipal ownership field: The tax rate may be increased in a community because the municipal government collects and disposes of ashes and garbage; but the increase may conceivably be materially less than the cost to taxpayers of having ashes and garbage removed by private contract.

AN UNUSUAL BUILDING CODE REVISION OPPORTUNITY.

Another start has been made toward the revision of the Building Code of New York City. The prospects for actual results on this occasion are better than they were at a similar time about a year ago. The Board of Aldermen, through its Building Committee, has appointed a commission of experts to report a revised code, and this commission is soon to begin its work. At first a commission of ten was appointed by the Building Committee; but this appointment left many political requirements unsatisfied, and before the Board itself would give its sanction to the arrangement its leaders demanded the doubling of the original number of members. As enlarged, the Commission comprises twenty-two members, and there is peace in the camp. In spite of the circumstances surrounding the formation of this commission, and in spite of its unwieldy make-up, we are optimistic enough to see a fairly bright prospect for real revision of the Code. For, not alone is there a hopeful proportion of good men in the Commission, but there is also a quite general appreciation of the need for revising the existing building regulations. Ultra-conservatism is to be found only in some narrow circles where the sentiment is: "We know the present Code and its interpretation, and it suits us; why should we be obliged to go through a new learning process?" We believe this sentiment will not prevail against the many forces working for improvement and progress.

There is a further reason why we may be optimistic about the forthcoming Code revision. The Commission has a rare opportunity to advance building practice and set a new model for municipal regulation of construction. The present New York Building Code has been widely quoted and widely copied ever since its formulation, seven or eight years ago. In many quarters it is still looked upon as a shining example; and so it is, in some of its details. But as a whole, as an instrument for procuring safe and rational building construction in a very large city, it has failed. Not that it has broken down altogether, for in its spirit and its specifications it is sounder than many of the buildings erected under it, certainly sounder than the Darlington cob-house and the Harlem and Bronx adobe flat-houses that collapsed before they were finished, at various times in the last few years. The failure of the Code is in part of two opposite kinds: on the one hand, it is insufficiently thorough and detailed, and insufficiently powerful, in practice, to protect; on the other hand, it is too cumbersome and awkward to leave the needed freedom to constructive and decorative genius. Like an old barge in a bad sea, the Code has proved neither stanch nor manageable in the stress of weather to which it was constantly subjected. The revisers of the Code have the opportunity of producing something better, something that will not fail in like manner, so that the New York Code will again merit being copied widely and adapted to the needs of other cities.

To accomplish this purpose will require much more than mere formal revision. It will not do to merely seek out the weak or bad clauses, recast them, strengthen them, and call the result a satisfactory piece of work. For, just as an old hulk can with difficulty be made tight, but can in no case have its awkwardness trimmed out of it, so the complex document forming the present Code cannot be patched into shape; it cannot hope for salvation without complete regeneration.

But, above all, the failure of the Code has been an administrative failure. The detailed specifications which it gives may have been at fault in many points, in the direction of either rigidity or laxity; but they have produced no gross difficulties. The paragraphs that called for a unit-load of, say, 11,200 lbs. in a column of such and such material and slenderness, or specified a 16-in. wall under certain named conditions, did not produce much poor construction or give rise to grave difficulties. The vital trouble has been in the matter of securing the actual enforcement of requirements that were clear and undisputed in themselves.

The enforcement of the Code is in the hands of a Bureau of Buildings in each of the five boroughs of the city. The work of such a bureau is in two divisions, first, examination and approval of plans, prior to issuance of a permit for the work, and second, inspection of the work during execution, to make sure that it is in accordance with the plans, and that the workmanship and general procedure satisfy the applicable provisions of the Code. In actual practice it has proven relatively easy, we believe, to do the examination of plans thoroughly and efficiently; but the other branch of the work, the inspection of construction, it has never been possible to carry out satisfactorily.

The latter is the prime reason for the administrative failure of the Code. It has never been possible for the Bureau to have a sufficient number of inspectors to obtain even moderate certainty that no unsafe or otherwise illegal work was being done in the various buildings being erected. Nor has it been possible—this is said without disparagement of the men employed in the inspecting force—to get inspectors of sufficiently high qualifications. The latter trouble, no doubt, could be remedied by paying higher salaries and by establishing strong civil service requirements. The other difficulty, insufficient number of inspectors, cannot be obviated, we believe, within any reasonable limits of expense and complication. Moreover, we hold the belief that it is not desirable to make any attempt to provide an inspecting force very much larger than now employed, certainly not to provide such an army of inspectors as would be needed to thoroughly cover the ground.

The elements with which municipal building control has to contend are of three main kinds: (1) ignorance or incompetence; (2) willful endeavor to evade the statutory provisions; and (3) defective system or centralization in the conduct of construction work, of such kind as to cause constant danger of serious error, unintended violation of law, or departure from plans. In a large city, where much building is going on, each one of these elements proves very troublesome, appears in many phases, and must engage the constant attention of the authorities charged with the supervision of building. They are found in all grades of work, moreover; and while they are much more ubiquitous in the cheap and cheapest grades of work, they are often most unattractable in the better grades of construction, due to the superior resource and influence of prominent architects, contractors or owners. We are probably correct in stating that the first-named tendency, incompetence, appears most frequently in the lower grades of work, and affects mainly matters of strength-provision; the second, willful evasion, appears in the lower grades as affecting structural strength, in the higher grades as affecting safety provisions and fire protection; while the third, defective system leading to error, appears principally in large work, in cases involving many subsequent changes of plans, and may affect any of the several items involved. Thus the municipal building bureau has no small aggregate of opposing forces to contend with.

Under the present system of administering building regulation in cities, almost no responsibility for proper, lawful design and execution rests upon anyone connected with the work, from owner down to mortar-mixer. Practically all the responsibility is on the city's building department. Take a case of a kind rather common in New York and other large cities: A real estate man, owning a building plot wants to put up a building of maximum profit-capacity at minimum cost. He seeks out an architect, explains his wishes, and bargains for the purchase of a set of plans suiting his purpose, the plans to be guaranteed to pass the building department. The price of the plans is forced down as low as the architect's business conscience will permit, so low, often, that if he has an old set of plans in his office which can be stretched, compressed or altered to fit the site, the new plans are worked up from these. After the owner has the plans and the building permit, he constitutes himself a General Contractor, for the purpose of erecting his building without paying for competent supervision; the architect has already disappeared from the scene. Sub-contractors for the foundation excavation, the masonry, the steelwork, the fireproofing (if there be any), etc., are secured at the lowest lump-sum prices that can be bargained for. Work then proceeds, according to the approved plans, under the owner's supervision (or that of his clerk), as badly or as well as the subcontractors' several consciences dictate; from time to time an inspector of the city building department visits the job to see that the masonry does not lag too far behind the steel, that the approved plans are being followed, and the like. There is no other eye than his to watch over the construction work, no conscience but his to enforce the law's demands. The Darlington case, fully discussed in our columns three years ago, was very much like this. It was testified after the collapse of that structure that the inspector in the district including this building was able to visit the work only about once a week. He had some fifty other buildings to "inspect." Of what went on during the six days of his absence from this particular building he could know little or nothing; anything wrong may have been put in, undetected unless it left evidence still visible at the end of the week. This is the degree of responsibility with which the municipal building authorities are burdened, and this is the way in which this responsibility is carried.

Work carried out in the manner described is not the rare phenomenon of once a decade, or once a year, but goes on constantly. The local chronicles of building activity give current evidence of it, and the owner shrewd enough to economize by

these practices is admired for his business sense and energy.

It will not do to set a municipal building inspector over each separate structure being erected in a city, to devote his entire time to its supervision, taking the place of a general superintendent or foreman for the contractor. The city can see no possible view charge itself with such a broad and responsible function. Full and proper supervision of construction work must be secured from the parties directly concerned in the structure—from owner or architect or both. How shall it be secured? That is one of the earliest and most important questions which the Commission on the New York Building Code should consider.

It is too commonly thought that a building law is primarily a specification for design and execution of work. That the administration is a vital problem, virtually basal to the whole question of the scope and make-up of such a law, is rarely recognized. Obviously it helps little against the deteriorating tendencies above mentioned, to put on the statute-books the provision that certain walls shall be 20 ins. thick, must be well bonded and shall not be laid up dry and grouted at intervals; the problem is to devise a system by which the 20-in. thickness and good masonry workmanship will actually be obtained. Honest and competent supervision, without detailed specifications in the law, would be certain to produce better results in this direction than complete specification with inadequate or totally absent supervision.

In most States of the country the architect, like the civil engineer, is not defined by law. He does not have to pass a certain examination, like the doctor or the lawyer; a blacksmith may hang out his shingle as architect, and the law will not interfere. Yet we can safely say that the vast majority of architects are men highly skilled in the design and construction of buildings, and able to supervise building contractors in a manner sufficient to ensure the objects of building laws. Why has there been no attempt to require by law that each architect shall supervise the buildings he designs? There is no reason for fearing that such a requirement would lead to a sudden increase of the number of incompetent architects, even without any effort to define the qualifications which an architect must possess.

It is not absolutely necessary to rely on the architect for the supervision that is so urgently needed. The essential thing is (1) to centralize a definite legal and technical responsibility on some one person, the superintendent of construction, or, better still, on this superintendent and the owner jointly and severally; and (2) to ensure that the supervision shall be competent and experienced. Suppose it were specified by law that every piece of building construction must be supervised, in full responsibility, by a registered Building Supervisor; and suppose it were further fixed by law that a person in order to be registered as Building Supervisor must possess certain specified qualifications of training and experience, or must pass a suitable examination: Would not such a system offer excellent guaranty against the evils of unsupervised, irresponsible building?

Whatever objections may be raised against these suggestions, we wish to insist most strongly on the absolute necessity of providing some device to ensure competent conduct of building work. And we trust that, whatever else the commission for the revision of the New York Building Code may consider and recommend, it will at an early stage of its work give thorough, conscientious consideration to this necessity.

We must point out, further, that whatever is to be prescribed in this direction must be made an integral part of the Building Code, not a separate law or ordinance. The supervision clauses will constitute the central, vital section of the Code, a section to which, in fact, all specification clauses will be merely subsidiary explanation.

When this matter is conscientiously decided, the Commission can proceed to consideration of other elements of necessary building regulation, where its opportunity for valuable reforms is also great. There are one or two large fields of municipal building control which are, up to the present, left in total neglect in this country. The Commission has the duty before it of studying these fields and deciding whether and how it can give them representation in a workable building code. We may confine ourselves here to a mention of but one of these, involving a question which is first in order, not necessarily of importance but of logic: The question of controlling such matters as height, interspace, and proportional ground area of buildings.

With an enormously rapid growth in number of tall buildings, in all districts of the city, residential, commercial and financial, the downward recession of the streets from the level of free light and air is reaching a serious stage. In Europe, with vastly less pressing conditions, there is already a distinct recognition of the fact that the welfare of the community requires restrictive measures to protect against this. The questions of interspacing of buildings, and proportion of free ground area, are of somewhat different character, yet related. In some sections, New York City is already approximating a state where it has contact with the atmosphere only along the house fronts and the roofs. The worst feature of this is not the restriction of light or air, because the buildings must be made attractive to tenants, and self-interest therefore watches over these desiderata in a measure. The serious thing is the transit question. Great assemblages of people are massed along narrow streets, with usually only one tributary street, a street utterly inadequate to give passage to all in an emergency, and badly congested even by the normal distributed traffic. May it not be feasible to secure by the general building regulations such provision of passages, courts and lanes in the skyscraper regions as would give more elbow room in the streets, at the same time ensuring a more healthful condition as regards light and air distribution, and greater opportunity for esthetic development of the city?

The subject of encroachment of buildings on street and sidewalk space, both at the surface and overhead, is a related matter for careful study. The unfortunate, injurious conditions existing in most cities are so patent, and have so often forced themselves on the attention of nearly every thinking citizen, that no detailed reference to them is required here.

LETTERS TO THE EDITOR.

Engineer's Estimates for Partial Payments.

Sir: An investigation of part of my work was made recently by the Division Engineer and the engineer for the head contractor for the satisfaction of a sub-contractor who thought his monthly estimate 20,000 to 30,000 yds. short.

The company pursues the policy of withholding from the contractor all knowledge of his estimate, the first that he sees of it being four to six weeks after it is made up, and the engineer for the contractor claimed that this secrecy was the cause of most of the trouble between contractors and engineers. He said that the contractor should be given a copy of the estimate at the end of each month showing in detail how the Resident Engineer arrived at the result.

The fact that in the above case the two estimates differed by less than 0.33% gives weight to his claim. I wish to know what is customary and what engineers and contractors think of it. "A Subscriber."

Lavina, Mont., Feb. 22, 1907.

Height of Center of Gravity as Affecting Liability to Derailment.

Sir: Referring to your article on "Curve Mechanics" in the Engineering News of March 7, 1907, I would like to ask if the height of the center of gravity of an engine or car above the rail affects the lateral pressure exerted on the outer rail of curves. In other words, does an engine traveling around a curve cause the same pressure on the outer rail as would another engine of same weight and traveling at the same rate of speed, but in which the center of gravity was lower?

Yours truly, C. W. S. Wilson.

New Rochelle, N. Y., March 7, 1907.

[There is no reason discoverable why the height of center of gravity above top of rail should affect rail pressure one way or the other. It will be true, however, that any lateral swinging or nosing of a car or locomotive, which swinging must, of course, be arrested by the wheel flange striking the rail, produces more severe impact against the rail when the center of gravity is low. For, with a high center of gravity more of the energy of the swing can be absorbed by rocking of the vehicle body on its springs. This leaves untouched the question whether, of two given vehicles, the one with lower center of gravity may not be smoother in running, and therefore produce less impact against the rail, than the car or engine of higher center of gravity.—Ed.]

Level Checks in the Survey Work in the Pennsylvania Railroad-Hudson River Tunnels.

Sir: In the description of the survey work of the Pennsylvania R. R. tunnels in Engineering News of Feb. 28, on p. 231, the following statement is made:

After the removal of the shields, a precise-level check was run to the middle of the river by both corps; they differed by 0.045-ft. in the North tunnel and 0.030-ft. in the South tunnel, the Manhattan levels being the higher in both cases. The mean of these two figures can be taken as the error of the original level transfer across the river.

The difference between the two checks is 0.015-ft. This is one-half of the least and one-third of the greatest discrepancy found in the level lines as carried out from each shore. This being the case it would seem to me that the author's assumption that the mean of the above discrepancies, viz., 0.0375-ft., can be taken as the error of the original level transfer across the river is a rather hasty conclusion. The difference between the two checks being as great as one-half of the least and one-third of the greatest discrepancy found would show so great a proportion of error in the check lines themselves as to make it unsafe to assume that the mean of the checks was the true result or even that the true result was between the values found by the two check lines. This being so it is therefore unsafe to assume that the mean discrepancy (viz., 0.0375-ft.) or that the total amount of either discrepancy (viz., 0.030 and 0.045-ft.) occurred in the original level transfer across the river.

The manner in which the two parts of the work, check lines and original level transfer, was done would probably influence the author in deciding to which to allow the greater weight, but the figures of the results as found would not justify the conclusion as published.

R. H. Blain.

Easton, Md., March 2, 1907.

The Management of the Pennsylvania R. R. New York Extension.

Sir: In the absence of General Raymond, I have received the marked copy of your valuable journal containing the article of Mr. James Forgie on the Hudson River Tunnels of the Pennsylvania R. R., which you so kindly sent him, and desire to thank you on his behalf for the courtesy.

This article is such a well written description of an admirable piece of work that it is perhaps ungracious to attempt to amend it in any particular. There is, however, one point that Mr. Forgie has inadvertently left open to misunderstanding. It does not do justice to the wisdom and foresight of the late Mr. Cassatt and Mr. Samuel Rea to describe the Board of Engineers as "pertaining to this work." Nor is it a Board of Consulting Engineers.

The Board of Engineers was organized by Mr. Cassatt in January, 1902, and commissioned to examine into the project of the Pennsylvania Railroad Company and the Long Island Railroad Company for the extension of their respective lines to a central passenger station in New York; to pass upon the practicability of the undertaking; to determine upon the best plans for carrying it out and to make a careful estimate of its cost, and if the conclusions were such (as they were) as to warrant the prosecution of the undertaking, to have a general supervision of the work of construction.

The Board meets, as a rule, once each week, and receives reports of the progress of the work from the Chief Engineers, as well as considering the leading features of the work.

To this work of determining upon the best plans for carrying out the project and generally supervising the work of construction, General Raymond has given practically the whole of his time since he retired from active service in the Corps of Engineers in 1904, not only in conjunction with the Board, but under independent instructions from the management.

Yours truly, H. T. Hildage.

1 West 34th St., New York, N. Y., March 8, 1907.

Ice Between Rail and Tie; The Mechanics of Curve Action.

Sir: The recent serious railway accidents on curves at high speeds seem to indicate clearly that in calculating the proper elevation of the outer rail some essential factors are overlooked. One of these neglected details seems to the writer to be the presence in winter of a

film of moisture between the tie and the rail base which is, of course, frozen, forming a frictionless foundation for the rail. The first passing wheel breaks this ice film and leaves two slippery surfaces in contact. Therefore at a curve nothing is left to hold the outer rail in place except the spikes and the sliding friction of steel on ice, on the upward grade due to the elevation of the outer rail. On several occasions the writer has watched the outer rail on a curve under above conditions, slide bodily outwards from 1/16-in. to 1/8-in. until brought up by the spikes, which were bent slightly backwards from the rail. This outward sliding of the rail can be prevented by tie plates with webs parallel to the rail forced downward into the tie and an upward projecting web against the outside of the rail; or a rail brace set into the tie can be used. To supplement this on high speed roads a guard rail should be required next the inner rail.

Another overlooked factor, which is peculiar to high speed electric traction is due to the gyroscopic action of the rotating armature, which strongly resists any deflection of its bearings from the direction in which it is traveling. A curve which may be perfectly safe for steam traction at high speed, may be much more severely tried by an electric train of the same weight at the same speed, on account of the greater weight and speed of the rotating parts.

To determine the value of these factors a dynamometer could easily be mounted on the outer rail of a curve and the actual thrust against it measured at different speeds and different elevation. The thrust of the king bolt against the car body could be determined by a dynamometer on the car. An armature free to move laterally on the axle against end of lever would give a means of measuring the end thrust of rotation at a curve. This matter should certainly have most careful and thorough investigation.

Then there has been a great increase in the weight of cars, engines, wheels and rails during the past few years, but the size of the spikes themselves has remained unchanged. Would it not therefore be well to consider the use of larger and stronger spikes of possibly the screw type so extensively used in Europe.

Very truly yours,
Harold P. Brown.

Montclair, N. J., March 7, 1907.

A Problem in Railroad Alinement.

Sir: I wish to call your attention to a slight error existing in your solution of "A Problem in Railroad Alinement," p. 163, Feb. 7, 1907. The angle at the foot of the first column should read DEA and DEA = 0° 28".6.

Would not the following solution have been more in line with the requirements?

Solve for angle DEA in random triangle.

Solve triangle DEA for EA and DA, giving AF.

Erect a perpendicular to AB at A to intersect FO at G. Drop a perpendicular from O upon AB at H. Draw GK parallel to AB, intersecting OH at K.

Solve triangle AFG for FG and AG.

Solve triangle GOK for GK and OK.

Thus obtain EH, OH. Let the curve intersect AB to right of A at L. Draw OL (= radius).

Solve triangle OLH for angle LOH and for LH.

EL = EH − LH = distance from section corner.

With angle FOL and radius find arc FL, thus locating L on the only lines logically recoverable.

Yours very truly,
Claude W. L. Filkins.

770 S. Broad St., Philadelphia, Pa., Feb. 10, 1907.

Sir: Referring to the problem proposed by Mr. O. Dix Johns, in your issue of Feb. 7, I have found the following solution convenient in practice, and it would perhaps be simpler in theory to one not accustomed to the use of analytics, than the solution proposed in your answer:

In your own illustration let FA = L, and the angle EAF = V. Call the intersection of the curve with the straight line P, and let angle FOP = J. Since, R sin J = L + R vers J cot V = L + R (1 − cos J) cot V; then, sin J tan V + cos J = $\frac{L \tan V}{R}$ + 1, in which J is unknown.

This reduces to an awkward quadratic, but in its present form is easily solved by inspecting the tables for the value of J which satisfies the equation.

In the present case, V = 68° 33.4′, tan V = 2.54603, L = 181.8′, R = 716.8′, hence

2.54603 sin J + cos J = 1.6440.

Referring to a table of natural sines and cosines it is at once apparent that J lies between 15° and 16°. I first tried 15° 40′; this proving too large I tried 15° 30′, which is the angle required.

To check your results:

x = R cos 15° 30′ = − 690.7.
y = R sin 15° 30′ = − 191.5.

J being known, the distance along the curve from the P.C. to P follows at once and the length EP = EA + $\frac{R \text{ vers } J}{\sin V}$.

By this method the computer can obtain as precise results as he cares to work for.

Very respectfully,
Owen M. Jones.

Tulane University, New Orleans, La., Feb. 14, 1907.

Sir: Mr. Johns' problem, stated in Engineering News, Feb. 7, 1907, may be solved entirely by trigonometry, as follows:

Call curve intersection H.

Solve triangle JKE for angle JEK (= 0° 28.6′).

Solve triangle AED for sides AD (= 15.2 ft.) and EA (= 1,710.5 ft.).

Solve triangle AFO for side AO (= 739.4 ft.), and angles AOF (= 14° 11.6′) and FAO (= 75° 48.4′).

Solve triangle AOH for side AH (= 28.1 ft.), and angle AOH (= 1° 18.4′).

The intersection required, H, may then be located from E by the angle DEA (= 0° 28.6′) and the distance EH (= 1,738.6 ft.), or by the distance FH (= 193.7 ft.) on the curve, computed from the angle FOH (= 15° 30′).

Yours truly, F. E. Foss.

Wilson, N. C., Feb. 16, 1907.

Notes and Queries.

"La Technique Sanitaire," of Brussels, Belgium, wishes to know whether there is in existence a prepayment water meter, and, if so, the name and address of the manufacturer. Such a device has never come to our attention and we doubt whether one has ever been put in practical use, even if some inventive genius has perfected designs for one. If any of our readers have information to the contrary we should be pleased to hear from them.

A London subscriber wishes to know if there is on the American market a small excavating plant, drawn by horses, which will excavate some 4 or 5 ins. of soil over any length of cut. The report has come to him that there is such a machine in use, costing approximately $200.

In the article on "Lowering the Chicago River Tunnels" in our issue of March 7, the cuts were misplaced. The drawing on p. 255 is that of the Van Buren St. tunnel, while that on p. 254 is the Washington St. tunnel. By a typographical error also it was stated (20th line on p. 254) that Mr. Samuel G. Artingstall was "assistant to Chief Engineer." He was, however, himself the Chief Engineer, in which position he has been succeeded by Mr. James Z. Murphy.

SOME FACTS AND FIGURES BEARING ON THE BRONX PARK DERAILMENT ON THE NEW YORK CENTRAL.

For a full month, ever since the wreck of a New York Central electric train by derailment at Woodlawn Road bridge, near Bronx Park, New York City, three investigations into that accident have been going on: that of the Coroner, that of the New York State Railroad Commission, and that of the railway company itself. The two former have concerned themselves mainly with the circumstances of and the responsibility for the wreck. The third has been primarily a determination of the relative curving qualities of the heavy steam passenger locomotives and the new electric locomotives operated by the company, and has sought to determine which type of engine is of more severe action on the track. At the present time we are in a position to give a summary including some of the results of all three investigations.

The sketch map herewith, Fig. 1, shows the track of the Harlem Division of the New York Central & Hudson River R. R. at the point of the wreck. Near the summit of a low grade (about ½%) the line makes a 3° 05′ curve to the left, passing under a bridge on the axis of Woodlawn Road. The bridge is about at the center of the curve, and the summit of the grade occurs practically at the same point. Thence northward extends a low descending grade, also about ½%. The curve has 4½ ins. superelevation and is spiraled, in accordance with good practice. The track has oak ties with steel tie-plates. Each rail is held by two spikes, one outside and one inside, at each tie; the rail weighs 100 lbs. per yd.

Electric locomotives were put into regular service for passenger traffic on the Harlem division on Jan. 28, 1907. [Details of the electric equipment of the New York Central's terminal section were given in an extended article in our issue of Nov. 16, 1905.] Snow and ice gave some trouble in connection with the third-rail shoes of the locomotives, and on the afternoon of Saturday, Feb. 16, it happened that a locomotive which was to haul the Brewster Exp[ress] out of New York had two broken third-rail s[hoes] on one side. In order to give a full set of [con]ecting shoes, as a precaution against inter[rup]tion of supply at crossings, another loc[omo]tive, which happened to have some disabled [col]lector shoes on the other side, was coupled to t[he] first, and the two engines in tandem took the t[rain] on its journey.

On the morning of the same day a trai[n] going north on the Harlem Division received a slight jolt at a point about under the Woodlawn Road bridge. The engineer at once reported "Rough Track." This report went through the Central office to the maintenance-of-way depa[rt]ment and by about 5 p. m. reached the section foreman of the respective section, who in co[m]pany with another employee thereupon at once made an inspection trip along the piece of t[rac]k in question. Finding nothing that appeared wrong, he returned without taking any action. It has since been concluded by the officials of the railway that the bridge casting a shadow on the roadbed kept the sun from having the same thawing action there that it had on the adjacent trackage, and that a hard spot in the track had thus been produced, which may have led to impact-action of passing trains, possibly producing a kink in the track or injuring a rail-joint.

The Brewster Express on Feb. 16 consisted of the two electric locomotives and five cars. Leaving New York at 6.13 p. m., it was delayed several minutes at the Mott Haven junction, five miles out, and then proceeded north. Just under the Woodlawn Road bridge, five miles farther, it was derailed. Four of the coaches were overturned upon the next track to the east, while the two engines and the first car rolled onward a quarter mile farther, with some wheels derailed. Twenty-four persons were killed or so injured that they have since died. The undetected trouble which caused the report of "rough track" eight hours before had apparently found its opportunity.

After the wreck the track at the site showed a displaced rail just under the bridge. It was the outer rail, and is on the central part of the 3° 05′ curve. This rail formed the north end of a track-circuit block section, and therefore had a Weber insulating rail-joint at its northerly end. [A similar joint was located in the inner rail half a rail-length farther north.] This joint was distorted so that the rail ends stood about 5 ins. out of alinement, the end of the southerly rail being forced outward that amount. The opposite end of this rail was shifted only a trifle out of position. The spikes on the outer side of the rail were sheared off clean, just at the level of the top of the tie-plate, and it was evident that the base of the rail had moved outward and sheared off the spikes, which were held by the tie-plates in a manner to facilitate such shearing action. Marks made apparently by derailed wheels were found on the ties as far back as the southerly end of this rail, and thence onward to the point where the engines stood. It could of course not be determined which portion of these marks had been made first, in point of time.

THE MATTER OF SPEED OF TRAIN.

The fact that four of the five cars were thrown over on their sides and lay on the next outward track caused newspaper reporters and other lay critics to jump promptly at the conclusion that the rare occurrence of tipping over from sheer excess of centrifugal force had taken place. The fact that the Salisbury (England) wreck is the only accident of this kind on record for many years, as occurring on a main-line railway to a train running under full control, was disregarded. That accident took place on a 10° curve with less than 3 ins. superelevation, with a train running at about 60 mi. per hr.; the tipping was inevitable. The Woodlawn curve of 3° 05′, with 4½ ins. superelevation, would require a speed of 100 to 120 mi. per hr. to produce similar tipping. There is no question of any such speed in this case. Yet, as the matter of speed is of prime importance, it requires careful attention.

The opinions of the engine-runner and an inspector who rode with him on the first of the two electric locomotives join in giving the speed

of the train as between 50 and 60 mi. per hr., possibly 55 as an average. Various passengers, however, testified that the train was running at exceptional speed just before the accident; one said he had never traveled at such speed before, although he often rode on fast trains. The train-sheet containing a record of the times at which the train was reported passing the several preceding signal towers shows that for a run approximately one mile the reported time difference was one minute, indicating a speed of 60 mi. per hr. But as these time reports give only the nearest minute, the actual speed thus calculated might have been anything from 31 mi. per hr. to an impossible figure.

The probabilities, however, are in favor of the view that the train was running at very high speed. Time had been lost, and the track was clear and had no bad grades or curves. The motorman had been only four days in charge of these electric locomotives, and had probably not yet become so accustomed to the remarkably smooth running of these engines that he might not be deceived thereby into underestimating the speed. He had the power of two engines behind him, which might cause him to run faster than he intended to. These electric locomotives have definite, well-known, characteristics as to speed and power [see curve sheets in Eng. News of Nov. 17, 1904]. It is stated authoritatively that on a straight, level track, without wind, such an engine running light acquires an ultimate speed of 86 mi. per hr. when the controller is in full parallel position. When hauling a train whose weight is 500 tons behind the locomotive, the ultimate speed will be 60 mi. per hr. The tractive effort of one locomotive, at the speed of 60 mi. per hr., is 5,600 lbs. The 500-ton train, weighing 596 tons with the locomotive, would then be showing a tractive resistance of 9.4 lbs. per ton. The train resistance at high speeds may be taken as roughly proportional to the square of the speed; that is, for this case it would be

At 65 mi. per hr., $9.4 \times \left(\frac{65}{60}\right)^2 = 11.05$ lbs. per ton.

At 70 mi. per hr., $9.4 \times \left(\frac{70}{60}\right)^2 = 12.8$ lbs. per ton.

At 75 mi. per hr., $9.4 \times \left(\frac{75}{60}\right)^2 = 14.7$ lbs. per ton.

At 80 mi. per hr., $9.4 \times \left(\frac{80}{60}\right)^2 = 16.7$ lbs. per ton.

The Brewster Express was hauled by two locomotives, having a tractive effort: At 55 mi. per hr., $2 \times 7{,}000 = 14{,}000$ lbs.; at 60 mi. per hr., $2 \times 5{,}600 = 11{,}200$ lbs.; at 65 mi. per hr., $2 \times 4{,}400 = 8{,}800$ lbs.; at 70 mi. per hr., $2 \times 3{,}600 = 7{,}200$ lbs.; at 75 mi. per hr., $2 \times 2{,}800 = 5{,}600$ lbs.; at 80 mi. per hr., $2 \times 2{,}600 = 5{,}200$ lbs. This train had a total weight of $2 \times 96 + 166.6 = 359$ tons, which figure includes an allowance of 20 tons for passengers. Allowing a grade resistance of 10.3 lbs. per ton for the 0.515% upgrade, the train resistance then is as given in the table below. The table gives also the tractive power of the locomotives, stated above. This latter is given for 600 volts supply potential. But it happens that the point of accident is near a substation, and we are informed that the substation voltage is 660 volts. It may be, therefore, that the Brewster Express in approaching the Woodlawn Road bridge curve was operating at somewhat higher third-rail voltage than the normal 600. The tractive power would be increased virtually in direct ratio with the voltage. Thus, supposing the train to obtain current at 625 volts, the tractive power would be as given in the last column of the table, which is to be compared with the train resistance given in the second column.

TABLE OF ESTIMATED TRAIN RESISTANCE AND TRACTIVE POWER, TWO 96-TON ELECTRIC LOCOMOTIVES HAULING FIVE CARS WEIGHING 167 TONS.

Speed Mi. per Hr.	Train Resistance, 359-Ton Train, Lbs.	Tractive Power, Two Locos., 600 Volts; Lbs.	Tractive Power, Two Locos., 625 Volts; Lbs.
60	7,070	11,200	11,700
65	7,665	8,800	9,170
70	8,290	7,200	7,500
75	8,975	5,600	5,840
80	9,690	5,200	5,410

This table shows that, with the controller in full parallel position, the two locomotives hauling five cars, a gross train weight of 359 tons, could reach an ultimate speed of about 67 to 68 mi. per hr. on a continuous up-grade of 0.515%, such as exists south of Woodlawn Road bridge.

It must be remembered that this estimate involves such degree of approximation that it is little more than speculative. Moreover, in any case it represents merely a possible maximum speed, and furnishes no direct evidence as to what the speed actually was. It has not been determined beyond contradiction whether or not the engine-runner of the Brewster Express had his controller in full parallel at the point of derailment, or for any distance back of that point.

The question of the speed at which the train was running being in such a vague state, we can do no better than to quote the opinion of an official of the railway company, which is to the effect that the train may have been making a speed of 75 mi. per hr. at the time of the accident.

AS TO THE CAUSE OF THE DERAILMENT.

Nothing has come to public knowledge, up to the present, that throws any clear light on the nature or causation of the derailment. The Coroner and Assistant District Attorney who have been collaborating in an investigation [the verdict of the Coroner's jury was published on p. 275 of our issue of March 7] make no secret of their opinion that excessive speed, and nothing else, was responsible. They had a computation of rail pressure made by Prof. Earl B Lovell, of Columbia University, New York City, who also made shearing tests of track spikes like those used in the track. He found an ultimate shearing strength of about 17,000 lbs. per spike. He held that all the guiding rail-pressure was exerted at one wheel, the leading outer driver; that all of this pressure should be figured to concentrate on one spike, on the view that the lateral stiffness of the rail might under some conditions not distribute any great part of the pressure to adjacent ties; that if one tie had settled slightly it might be carrying none of the vertical load of a passing wheel, so that there would be no frictional resistance between rail-base and tie-plate; and that, consequently, the entire guiding rail-pressure might be exerted as a shearing force on a single spike. On this basis he calculated that the elastic limit of the track spikes in shearing might be reached at a speed between 40 and 50 mi. per hr. Objection may reasonably be made to the propriety of assuming that the full lateral pressure of one wheel can be concentrated on one tie, which assumption implies the failure of the distributing action of the rail, although the rail is a very stiff girder laterally on the span length of about 20 ins. between ties. Further, the construction of the two-wheel leading truck of the electric locomotive is such that the outer truck-wheel must necessarily take a material part of the lateral guiding pressure, thereby diminishing (or at low speeds even reversing) the rail pressure at the first driving axle. This will be more fully discussed below.

Concerning other explanations of the cause of the accident, we may say that they are almost zero, as far as relates to definite theories. The railway officials themselves do not propose a distinct theory, not even the simple one that a fallen bolt or brake-beam or the like got under a wheel, forced a rail out of place, and derailed the train. Some suggestion of this as a cause has been made, but not in very definite form. After the wreck the rear truck-wheel of the leading locomotive on the inside of the curve was found to have lost a retaining ring, due to the retaining-

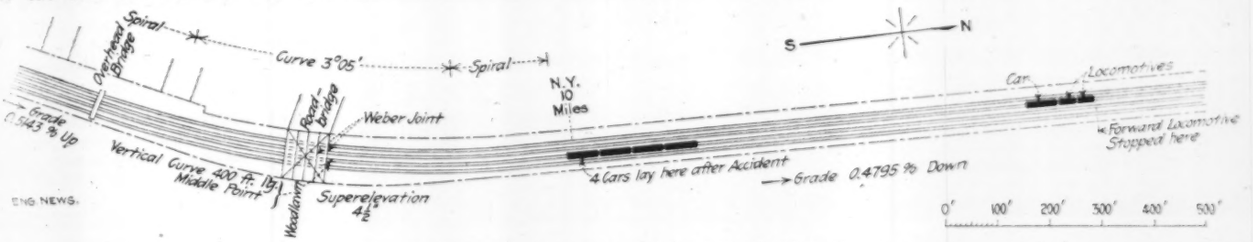


FIG. 1. PLAN OF TRACK OF HARLEM DIVISION, NEW YORK CENTRAL & HUDSON RIVER R. R., AT SITE OF DERAILMENT OF BREWSTER EXPRESS, FEB. 16, 1907.

The train bound north from New York to Brewster, N. Y., ran on the second track from the west side. It was derailed just under the Woodlawn Road bridge. The outer rail just south of the Weber insulating joint was shifted outward, shearing off the spikes on its outer side; the most southerly spike sheared off is located approximately under the southerly edge of the bridge.

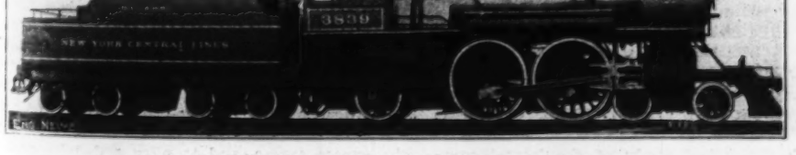


FIG. 2. STEAM PASSENGER LOCOMOTIVE, ATLANTIC TYPE. WEIGHT 95 TONS (WITHOUT TENDER).

FIG. 3. ELECTRIC LOCOMOTIVE IN ELECTRIC TERMINAL SERVICE, NEW YORK CENTRAL & HUDSON RIVER R. R. WEIGHT 96 TONS.

The two engines are shown to the same scale.

ring bolts having been sheared off after the wheel left the rail.

There appeared, also, some indentations on the tread of the two outer wheels of the front truck of the smoker, the car immediately behind the locomotives. These may as probably indicate that the wheel struck the end of a displaced rail as that it struck a foreign object. But the main point is this: that if the "foreign object" explanation be the proper one, the derailment is more commonplace, and hardly carries any strong teaching. The present great interest in the accident, a very proper interest, is based on the possibility that the train exerted so great a lateral pressure on the rail as to force it outward, shearing off the spikes which held it in place.

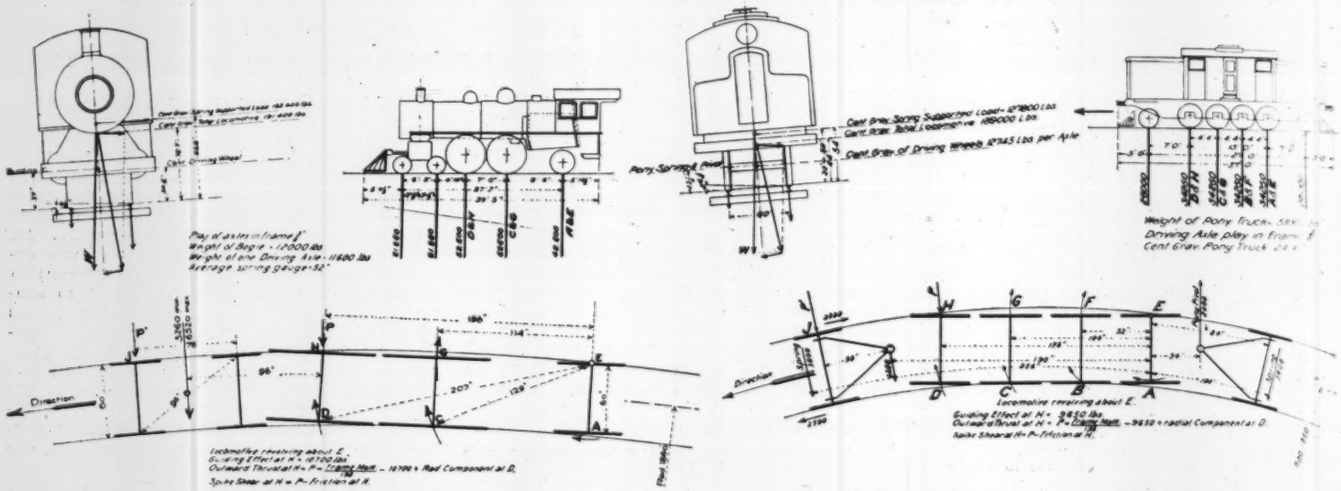
In this connection the fact is of moment that the electric locomotives which figure in the derailment are of quite different weight, length, and frame arrangement from the usual types of steam locomotive. On this score there has been a great deal of criticism of the railway company for its alleged failure to test the new motive-power thoroughly before putting it into service in order to determine whether it is safe to operate, and what are the maximum safe speeds for running it over the existing tracks of the several divisions of the Electric Zone. We may recall, therefore, that the first electric locomotive was most thoroughly tried out on a six-mile stretch of track near Schenectady, N. Y., being run for a period of about 18 months, making 50,000 miles, before the design of the lot of locomotives was adopted. The test track was distinctly inferior to the class of track found on the main lines in the Electric Zone, being 80-lb. rail on gravel ballast as compared with 100-lb. rail on stone ballast; the test was therefore considered to have given opportunity for developing all weaknesses in both track and engines which might otherwise develop only in actual service.

Two results of this test running deserve mention. The first is that, as first built, the electric locomotive seemed to have a rather unreasonably large destructive action on the track, producing lateral distortion. The cause was discovered in the construction of the two-wheel leading truck. A new type of truck was then developed, and this proved very successful; its arrangement has bearing on the rail pressures developed by the locomotive, as will appear farther on. The second test-observation which we wish to note is that on one occasion, when the engine was being run at a speed of 75 mi. per hour around a 2° 30′ curve superelevated for a maximum speed of 60 mi. per hr., the engine displaced the track bodily, shifting it in the (gravel) ballast a perceptible amount, without however disturbing the gage. As the entire centrifugal effect at this speed and curvature, for the 96-ton engine, on a track without any superelevation, would be only 31,000 lbs., it may be concluded that the track was not ideally tamped. But it is equally apparent that the accepted type of spike fastening of the rail underwent a severe test when the spikes held sufficiently to allow the train to shift the track.

RAIL PRESSURES OF ELECTRIC AND STEAM LOCOMOTIVES.

A very interesting consequence of the criticism which has been directed at the use of the electric locomtoives is that the New York Central & Hudson River R. R. has been led to make a thorough theoretical study of the lateral pressures generated when a locomotive rounds a curve in the track. This study was made to give a basis for computing the rail pressures of the electric locomotives (Fig. 3) and of a Atlantic (4-4-2) engine (Fig. 2) such as for fast passenger service on the line. The results of this study, which was made office of Mr. W. J. Wilgus, Vice-Presi charge of electrification, with the collab of the General Electric Co. and the Am Locomotive Co. [who designed and built t tric locomotives], are not at present avail us. However, the resulting figures for types of engine mentioned are at hand, tabulated below the corresponding dia diagrams reproduced here as Fig. 4.

Certain construction details of the electr motives have important bearing on the tion. The eight driving-wheels are all in accordance with regular practice on pa locomotives on the New York Central axles are mounted in a rigid frame; they however, an end play of about ⅜-in.



NOTE: Instead of the formula noted in diagram, read: Outward

$$\text{Thrust at H} = P = \frac{\text{Frame Mom.}}{198} - 10{,}700 + \text{Rad. Comp. at D} + \text{Centrif. Effect at H.}$$

NOTE: Instead of the formula noted in diagram, read: Outward

$$\text{Thrust at H} = P = \frac{\text{Frame Mom.}}{156} - 9{,}650 + \text{Rad. Comp. at D} + \text{Centrif. Effect at H.}$$

STEAM LOCOMOTIVE, ATLANTIC TYPE.

Speed	Weights on Rigid Wheel-base.				
M. P. H.	A	C	D	G	H
40	22,120	27,085	27,085	25,165	25,165
50	20,540	25,365	25,365	26,885	26,885
60	18,590	23,245	19,545	29,005	32,705
70	16,590	21,055	14,555	31,195	37,695
80	13,640	17,945	7,245	34,305	45,005

Speed	Cent.	Friction Resist., Rigid Wheel-Base					Rad. Comp.
M. P. H.	Eff. at H.	A	C	D	G	H	at D
40	— 380	5,530	6,770	6,770	6,280	6,280	6,280
50	1,970	5,130	6,340	6,340	6,720	6,720	6,080
60	7,450	4,650	5,810	4,890	7,250	8,170	4,680
70	13,090	4,150	5,260	3,640	7,800	9,420	3,500
80	21,050	3,410	4,480	1,810	8,580	11,250	1,730

Speed	Pressure and Spike-shear at H—Axle G-C not against rail.		Axle G-C against rail.		Pressure and Spike-shear at J Spike-shear.
M. P. H.	P	Spike-shear.	P	Spike-shear.	P′
40	6,120	.....	6,260	.....	7,830
50	7,450	730	6,220	.....	7,950
60	11,230	3,060	5,460	.....	8,130
70	15,390	5,970	7,570	.....	8,170
80	21,160	9,910	13,020	1,820	8,200

ELECTRIC LOCOMOTIVE.

Speed	Weights on Rigid Wheel-base.						
M. P. H.	A	B	C	D	F	G	H
40	14,325	20,570	18,500	17,500	13,725	15,745	16,750
50	13,775	19,975	17,100	16,800	14,275	17,140	17,450
60	13,125	19,300	15,945	15,645	14,945	18,300	18,005
70	12,425	18,500	14,300	14,300	15,745	19,355	19,350
80	11,425	17,600	13,770	12,770	16,650	20,470	21,480

Speed	Cent.	Fric. Resist., Rigid Wheel-base.						
M. P. H.	Eff. at H.	A	B	C	D	F	G	H
40	— 1,590	3,600	5,150	4,620	4,380	3,440	3,920	4,180
50	1,320	3,450	4,980	4,300	4,200	3,560	4,280	4,300
60	4,880	3,300	4,800	3,980	3,900	3,740	4,560	4,650
70	9,050	3,130	4,620	3,720	3,580	3,940	4,830	5,000
80	13,790	2,900	4,400	3,430	3,200	4,150	5,100	5,300

Speed	Rad Comp.	Pressure and Spike-shear at H—Axle G-C not against rail.		Axle G-C against rail		Pressure and Spike-shear at J Spike-
M. P. H.	at D.	P	Spike-shear	P	Spike-shear	P′ Shear.
40	4,080	4,740	560	3,880	.....	6,410 2,410
50	3,930	7,400	3,040	4,120	.....	6,600 2,570
60	3,640	10,470	5,820	4,480	.....	6,830 2,780
70	3,350	14,130	9,130	7,460	2,460	7,100 3,020
80	2,970	18,380	13,000	11,000	5,640	7,400 3,300

FIG. 4. DIMENSION DIAGRAM AND TABLE OF RAIL PRESSURES, FOR ATLANTIC STEAM LOCOMOTIVE AND ELECTRIC LOCOMOTIVE ON CURVE OF 3° 5′ WITH 4 1-2 INS. SUPERELEVATION.

The two-wheel guiding truck is of the radial swivelling type, but instead of having its load carried to it by swing-hangers, as commonly in truck construction, a radically different detail is used. The load on the truck is carried to a horizontal plate, with planed lower surface, which rests on a second planed plate attached to the truck; the pair of plates is surrounded by a covered box filled with oil, so that it constitutes a sliding bearing of metal on metal with permanent copious lubrication. Two opposed springs lying horizontally on a transverse line are provided to hold the truck central with respect to the engine frame, and to offer a definite resistance to the forced lateral deflection of the truck at curves. The initial compression of this spring device is about 3,400 lbs., and this force is in-

boxes, which permits adjustment to curves. The engines are completely symmetrical, end for end.

...d by about 700 lbs. per inch of deflection of ...ck. The springs are some distance forward ... truck axle, and act against the forward ... the radius-bar. They thus have an in... effect in producing pressure of the ... wheels against the rail; making this rail-... about a third greater than the spring ... An element of rail-pressure in com... with an equal reaction at the pivot of ... radius-bar must also produce the longitudinal ... slipping of the truck. In addition the rail-... is increased by a further force equal to ... friction of the sliding bearing. The load on the ... is about 21,000 lbs., and with a coefficient ... the friction would be 1,470 lbs. This fric... will be active at least while the engine is ... entering transition curve or spiral, and ... indeed act even throughout the central or ... curve. Since a definite guiding force ... provided at the truck, the guiding work ... for the first driver to do is by that much ... The ordinary swing-hanger truck con... accomplishes this in a much less definite ... therefore less satisfactory manner.

The calculations whose results are given in Fig. 4 were made by computing the lateral and longitudinal slipping of the wheels and the effect of the centrifugal force, under two possible sets of conditions: (1) that the second pair of drivers has insufficient end play in its bearings, so that it cannot bear against the rail and take up its own curve-sliding pressure; (2) that the second pair of drivers has enough end play so that it can take up its own contribution to the rail pressure. This second case means simply less pressure at the leading outer driver, but leaves the truck-wheel pressure unchanged. In computing the truck-wheel rail pressure, the spring force only was counted on, that is, the friction of the sliding bearing was neglected, to be on the safe side. This gives the highest possible driver pressures.

Two minor factors which may affect the rail-pressure, both as to amount and distribution, were left unconsidered in the calculation. These are angularity of drawbar-pull, and gyroscopic effect of the rotating armatures and wheels. Both effects are doubtless small, and the gyroscopic effect modifies not the horizontal but only the vertical rail-pressures.

The sliding friction between wheel and rail was computed at 0.25. The same factor was subsequently used is estimating the friction between rail and tie-plate tending to hold the rail in place. Applying this factor to the calculated wheel-load, as also given under Fig. 4, gives the amount of the friction, and by subtraction from the total rail-pressure at that point the effective force tending to shear the spike is obtained. This force is given in the tables in Fig. 4 in the columns headed "Spike Shear."

It is the contention of the New York Central that the spike shear may be computed as resisted by two ties, that is two spikes. The shearing force on a single spike is, then, half the amount of the respective figures in the tables of Fig. 4. From these values the authorities of the New York Central deduce the conclusion that, with an ultimate shearing strength of 14,440 to 17,060 lbs. per spike, a factor of safety of about 7 is obtained, for speeds up to 80 mi. per hr., with the locomotives covered by the calculation.

In the absence of the details of the analysis, we are not prepared to vouch for the accuracy of the calculations summarized in Fig. 4. It appears that the total centrifugal tendency of the 189,000-lb. locomotive moving around the 3° 5′ curve at a speed of 80 mi. per hr. is 43,710 lbs. Of this, 14,200 lbs. is balanced by the effect of the 4½-in. superelevation, leaving a net centrifugal pressure of 29,510 lbs. Of this amount the centrifugal action of the trucks and the middle groups of wheels, axles and armatures, which is taken up at the corresponding wheels, would account for about 5,580 lbs. The remainder is 23,930 lbs. It is difficult to see how this can distribute otherwise than to the first and fourth outer drivers, which would give a pressure of 11,965 lbs. for each of these (half to each, since the center of gravity is at the center of length). Yet the table in Fig. 4 gives a total maximum rail-pressure at the front outer driver of 18,360 lbs. when the guidance of the second axle is included, and only 11,000 lbs. when the latter does its own guiding; the latter figure, however, is already less than the 11,965 lbs. of centrifugal force going to this driver, thus leaving less than nothing for the guiding pressure needed to produce the curve-slipping. This seems to point to errors in the computation, unless indeed the electric locomotive is "overguided," that is, the truck-wheel pressure is more than sufficient to effect the curve-slipping of the entire locomotive. However, proper criticism is not possible before an exposition of the method of analysis in full is at hand.

What may be concluded with good reason, however, from the values in Fig. 4, is that the comparison between the steam and the electric locomotive in the matter of rail-pressure does not show inferiority of the electric engine. The maximum pressures, summarized in the following tabulation, show that generally the steam locomotive produces the greater pressures. This point, we understand, was a primary object of the calculation in question.

Comparison of Electric and Steam (Atlantic) Locomotive as to Maximum Rail Pressure and Spike Shear, and Location of Wheel (Front outer driver or outer truck-wheel) Giving The Maximum Pressure.
3° curve; 4½ ins. Superelevation; Friction Coefficient 0.25.

I.—Second Driver Not in Bearing Against Outer Rail.

Speed. Mi. per Hr.	Rail Pressure. Engine.	Wheel.	Amount, Lbs.	Spike Shear. Engine.	Wheel.	Amount, Lbs.
40	Steam	Truck	7,830	Steam	Truck	4,630
50	"	"	7,950	"	"	4,740
60	"	Driver	11,230	Electric	Driver	5,820
70	"	"	15,390	Electric	Driver	9,130
80	"	"	21,160	Electric	Driver	13,000

II.—Second Set of Drivers in Bearing Against Outer Rail.

Speed. Mi. per Hr.	Rail Pressure. Engine.	Wheel.	Amount, Lbs.	Spike Shear. Engine.	Wheel.	Amount, Lbs.
40	Steam	Truck	7,830	Steam	Truck	4,630
50	"	"	7,950	"	"	4,740
60	"	"	8,130	"	"	4,890
70	"	"	8,170	"	"	4,840
80	"	Driver	13,020	Electric	Driver	5,640

The clearances of the axles endwise in their bearings, and the curvature of the rail on a 3° 05′ curve, are such that the second driver is probably able to work its way to contact with the outer rail under the influence of the outward forces. Therefore the second condition will apply, rather than the first, and the smaller set of values for the pressure at the front driver must be accepted. In this condition, i. e., with the second driver against the rail, it will be noted that at speeds less than 70 mi. per hr. there is no resultant spike-shear at the first driver; and at 70 mi. per hr., while the spike-shear at the leading electric driver is 2,460 lbs., the greatest spike-shear under the steam locomotive, which occurs at the leading truck-wheel, is almost 100% greater, namely 4,840 lbs.: a very favorable showing for the electric locomotive.

It will be seen from the diagrams in Fig. 4 that the electric locomotive differs markedly from the steam locomotive in height of center of gravity, which is 72½ ins. in the latter and only 44 ins. in the electric engine, or less than two-thirds as much. As concerns mere static rail-pressure, this height is of no influence. But all lateral oscillation and impact will vary in their effect with this height. When the center of gravity is high, motions of the underframe or of the spring-supported weight will have less tendency to be transmitted up or down respectively, on account of the greater amount which can be taken up in lateral rocking on the springs. But the general riding qualities of the particular engine have much to do with this matter. If the electric locomotive inherently has less tendency to swinging, oscillation or nosing than the comparison steam locomotive, it may be less severe on the track in spite of the effect of lower center of gravity. Actually, it is reported by competent observers that the New York Central electric locomotives run with remarkable smoothness, and that there is an entire absence of swinging or nosing. The absence of reciprocating machinery, and also the special truck construction before described, are credited with this result.

In summary, it may be said that the investigation of this accident has shown not the slightest reason for charging the new type of motive power with any causative relation to the disastrous derailment. The most that can be said is that two electric locomotives coupled together, able to bring a following train of 167 tons up to a speed of nearly 70 mi. per hr., may be a source of danger unless all the trackage is thoroughly known to be safe against all unfavorable conditions and mischances at such speed. This latter seems to remain the crucial point: Is our standard track construction amply able to meet the full demands of safety under heavy and high-speed traffic. In spite of the calculations quoted above, evidence is fast multiplying that it is not safe enough. Further development in track standards must be looked to.

THE DEDICATION OF THE NEW ENGINEERING Societies Building, 33 West 39th St., New York City, will occur during the third week of April. Tuesday afternoon, April 16, will be devoted to the formal dedication exercises. These will be followed in the evening by a general reception. Wednesday, April 17, will be known as Founders' Day, and the afternoon will be devoted to addresses by representatives of the three founder societies; greetings for sister societies; the presentation of medals, etc. Thursday and Friday, April 18 and 19, will be given over to professional sessions of the founder societies. The American Institute of Mining Engineers will hold a session Thursday afternoon, when a paper on "Mining Engineering in New York City," describing the excavation and tunnel work now being carried on by the Pennsylvania R. R., will be read by Mr. H. T. Hildage. In the evening Brig.-Gen. William Crozier, U. S. A., will address the American Society of Mechanical Engineers on "The Ordnance Department as an Engineering Organization." On Friday afternoon the American Institute of Electrical Engineers will hold a professional session. The exercises will close Friday with an informal smoker for members of all societies. As is generally known, the new building has been in use since the first of the present year, when the different societies took up their headquarters there. It was, however, decided to postpone the dedicatory exercises until the building was entirely furnished and everything was in smooth working order.

A BATTLESHIP MAGAZINE EXPLODED on the French battleship "Jena" in the harbor of Toulon, France, on the afternoon of March 12. The battleship was lying in a dry-dock in one of the harbor basins when, at 1.30 p. m., a heavy explosion occurred on board. Minor explosions continued for a long time, making attempts at rescue difficult. According to the news at the time we go to press the disaster involves the death of anywhere from 50 to 250 persons, all of whom were in service on the vessel. The fire and continued explosions were finally checked by flooding the dock.

THE EXPLOSION of a Pennsylvania R. R. freight engine boiler at Metuchen, N. J., March 11, killed three trainmen and badly damaged the passenger station and several other buildings.

A DYNAMITE EXPLOSION at the Richards Colliery of the Susquehanna Coal Co., near Mount Carmel, Pa., March 5, injured some forty persons, one fatally, and damaged property to the extent of $150,000. The dynamite house is said to have contained 1,000 lbs. of dynamite at the time of the accident. The explosion wrecked the office, the supply house, the carpenter shops and two large hoisting engines.

PREMATURE EXPLOSIONS OF DYNAMITE in a quarry of the Chihuahua & Pacific R. R., at Chihuahua, Mex., March 5, killed nine men and injured as many others. Two explosions occurred, the second one burying the men injured by the first. Another report states that an explosion of dynamite at San Andoes, a mining town 60 miles from Chihuahua, killed 35 persons March 8.

DERAILMENTS OF TRAINS have been rather plentiful this week, as was also the case last week. On March 5 a southbound fast passenger train on the main line of the New York Central & Hudson River R. R. was derailed at Tivoli, N. Y. A fault in a rail is supposed to have caused the derailment. No one was killed. On March 6 a passenger train on the Pennsylvania R. R. left the track at a badly-set switch near Warren, Pa., and rolled down the embankment. Nobody was killed. On March 9 an eastbound limited train on the main line of the Pennsylvania R. R. was stopped at Cresson, Pa., through the derailment of one truck of the third car. The rest of the train was not affected. No one was injured.

ICE wrecked the Chicago, Milwaukee & St. Paul Ry. bridge across the Missouri River at Chamberlain, S. Dak., March 10. The ice banked up against the abutments and carried away some 600 ft. of the bridge.

A MINIATURE AVALANCHE of ice wrecked a trolley car of the Gorge Route at the Whirlpool Rapids, Niagara Falls, N. Y., March 12, killing the conductor and injuring five other people. The car was waiting to take a switch, when the ice became detached from the cliff and sliding down the steep bank crushed the car.

THE IMPROVEMENT OF SOCIAL AND LIVING CONditions in the United States is the object of the Sage Foundation, for the endowment of which Mrs. Russell Sage has "set aside $10,000,000." A bill incorporating the Foundation has been introduced in the New York legislature. Among the incorporators named are Robert W. de Forest (7 Washington Sq., N., New York City), recently Tenement House Commissioner of New York city; Daniel G. Gilman, recently President of Johns Hopkins University; and Miss Helen Gould. The work to be carried on

will include research, publication, education, the establishment and maintenance of charitable and beneficial activities, agencies and institutions and the aid of any such activities, agencies and institutions already established. It will be within the scope of such a foundation to investigate and study the causes of adverse social conditions, including, ignorance, poverty and vice, to suggest how these conditions can be remedied or ameliorated, and to put in operation any appropriate means to that end.

THE WATER SUPPLY AND FIRE PROTECTION OF St. Augustine, Fla., has been reported on by the Committee on Fire Prevention of the National Board of Fire Underwriters (135 William St., New York City). The committee recommends that the supply works be developed to a capacity of at least 4,000 gals. per min. for a period of six hours, and states that this can be done by increasing the yield of the wells or by adding a storage reservoir. It also recommends the remodeling of the pumping station so as to eliminate combustible material; the installation of two additional pumps of at least 3,000,000 gals. capacity each; provision of sufficient boiler capacity to supply steam for a pumpage rate of 4,000,000 gals.; and the addition of a 12-in. and an 8-in. water main. The committee states that the fire department is "undermanned and equipped mainly with unreliable or unsatisfactory apparatus"; that there is practically no fire alarm system, telephones being used; that there are practically no building regulations; and that the city has no control of electric wiring.

TWO PUBLIC SERVICE COMMISSIONS for the State of New York are provided for by the so-called Page-Merritt bill, recently introduced in both branches of the New York legislature. One commission would have jurisdiction in New York City and the other throughout the remainder of the State. In general, the powers and duties of the two commissions would be identical, except that the commission having control in New York City would supersede the present Rapid Transit Commission. The two commissions would have very complete supervision of all the railroads, street railways and other common carriers of the State, and also of all gas and electric light companies. Each commission would consist of five members at a salary of $10,000 a year each, and would be provided with a counsel at $10,000, and a secretary at $6,000 a year, besides having authority to employ various clerks, inspectors, experts, etc. The members of the two commissions, aside from some of the first appointees, would serve for terms of five years. They would be appointed by the governor, with the approval of the Senate. The expenses of the commission acting within the city of New York would be met by the city on requisition to the financial officers thereof. For the commission outside the city, the act appropriates $150,000 for the expenses of the first year. The two commissions are given extensive authority to adjust the rates charged by the various public service corporations under their control and to investigate railway accidents. Stock and bond issues of the various corporations would be subject to the approval of the commissions. The commissions would have power to require uniform accounts and reports from the various classes of public service corporations and from municipalities supplying gas and electricity and would have broad powers of control of the character of the services rendered by the companies. No municipality would be allowed to "build, maintain and operate for other than municipal purposes any works or systems for the manufacture and supplying of gas or electricity for lighting purposes, without a certificate of authority granted by the commission." The duties now vested in the State inspectors of gas and electric meters and in the present Commission of Gas and Electricity would be transferred to the new commissions.

NOTES FROM ENGINEERING SCHOOLS.

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY.—Exercises will be held March 18, at 8 p. m., in commemoration of the eleventh anniversary of the granting of the charter by the University of the State of New York. The address of the evening will be given by Mr. Frederick Remsen Hutton, President of the American Society of Mechanical Engineers and Professor of Mechanical Engineering at Columbia University, New York City.

CORNELL UNIVERSITY.—A meeting of the Cornell Branch of the American Institute of Electrical Engineers was held March 8. Mr. J. S. Codman, Rate Specialist of the General Electric Co., read a paper on "Rates of Charge for Electricity and their Effect on Cost." After discussing the general conditions that effect rates, Mr. Codman noted methods of improving load factor, different systems of charging for current, the justice of these methods, etc. At a previous meeting Mr. R. L. Stone was elected a member of the Executive Committee to represent the undergraduates of the Branch.

PERSONALS.

Mr. Paul McGeehan has been appointed Chief Engineer of the Newton & Northwestern R. R., to succeed Mr. Chas. H. Peck, resigned.

Mr. J. G. Sullivan has been appointed Manager of Construction of Eastern Lines of the Canadian Pacific Ry., with offices at Toronto, Ont.

Mr. Albert W. Honywell has been appointed Superintendent of the Hartford Division of the New York, New Haven & Hartford R. R., to succeed Mr. W. L. Derr, resigned.

Mr. William Brainbridge, Superintendent of the El Paso Mine, has been appointed Manager of Construction Work on the Cripple Creek drainage tunnel. He will serve in both capacities.

Mr. Gerard Van Tassell, Trainmaster of the Harlem Division of the New York Central & Hudson River R. R., has been promoted to be Superintendent of that division, to succeed Mr. Miles Bronson, resigned.

Mr. Loomis F. Goodale, Engineer of Maintenance of Way for the Chicago, Burlington & Quincy R. R., at St. Louis, Mo., has been appointed Supervising Engineer of Railroad Construction in the Philippines for the United States Insular Commission.

Mr. Edgar B. Kay, Professor in Charge of the Engineering Department of the University of Alabama, has been retained to prepare plans and to superintend the construction of a combined electric light and waterworks plant for Citronelle, Ala.

Mr. E. E. Lillie, recently assistant in the General Superintendent's office of the Great Northern Ry., at St. Paul, Minn., has been appointed Superintendent of the Spokane & Inland Division of the Inland Empire Ry., with office at Spokane, Wash.

Mr. Robert E. Carrick, formerly General Superintendent for the Unit Concrete-Steel Frame Co., of Philadelphia, Pa., and recently General Engineer for Tucker & Vinton, New York City, has accepted a position with the General Fireproofing Co., of Youngstown, O.

Mr. J. C. Sayter has been appointed Superintendent of Terminals at Fort William, Ont., for the Canadian Pacific Ry. Mr. C. S. Maharg has been appointed to a similar position at Brandon, Man., and at Moosejaw, Assiniboia. Mr. G. Egeshan has been appointed to that position.

Mr. R. W. Willis, Division Engineer of the Chicago, Burlington & Quincy R. R., has been made Engineer of the Missouri District of the System. Mr. John C. Sesser, Superintendent of Construction on the Centralia-Herrin line of the System, has been promoted to Engineer, Maintenance of Way.

Major William W. Harts, Secretary of the California Debris Commission, has been appointed United States Engineer in charge of rivers and harbors in California, to succeed Col. W. H. Heuer, who is retired. Major Harts graduated from West Point in 1889 and has since been engaged in army engineering work.

Mr. John R. Magarvey, Superintendent of the Brooks Plant of the American Locomotive Co., has been promoted to be Manager of these works. Mr. J. R. Marshall is promoted from Standard Practice Engineer to Superintendent, and is succeeded by Mr. Harry Hayes. Mr. Earl C. Haggett has been appointed Assistant Superintendent.

Mr. Edwin C. Eckel, Assoc. Am. Soc. C. E., has resigned as Geologist of the U. S. Geological Survey, and has opened offices at 208-209, the Munsey Building, Washington, D. C., as an expert in cement materials. While connected with the Geological Survey he was in charge of all geologic investigations relating to cement and other structural materials, and he now proposes to make a specialty of reports and examinations of cement properties and materials.

Mr. F. H. Newell, Chief Engineer of the U. S. Reclamation Service, has been appointed Director of the Service. The Reclamation Service has heretofore been a branch of the U. S. Geological Survey, but now, on account of its size, it has been made a separate bureau of the Interior Department of the Government, with a head of its own. Mr. Newell is a graduate of the Massachusetts Institute of Technology, class of 1885, and has been connected with the national reclamation work since its inception. Prior to that he had been, since 1888, in the topographic division of the U. S. Geological Survey.

The following changes have taken place in the personnel of the Reclamation Service: Mr. James W. Martin has been appointed Engineer and assigned to the Salt River Project, Arizona, where he will have charge of the construction of the diversion dam. Messrs. Arthur B. Cleaveland and George A. Sampson have been appointed Assistant Engineers and assigned to the Belle Fourche Project. Mr. Mason I. Chapin has been appointed Assistant Engineer and assigned to the North Platte Project. Messrs. Leo J. Foster, Frederick W. Cater and Tracy I. Phelps have been appointed Engineering Aids and assigned to the Uncompahgre Valley Project. Mr. William G. Dow has been appointed Engineering Aid and assigned to the North Platte Project. Mr. Robert P. Ewald has been appointed Engineering Aid and assigned to the Belle Fourche Project.

Obituary.

Lester Bradford Gardner, a well known mechanical engineer of Mt. Vernon, O., died at Omaha, Neb., March 7, aged 88 years.

John North, a mechanical engineer of Hartford, Conn., died at that place, March 7, aged 86 years. He was a native of Middletown, N. Y.

Harry C. Hoefinghoff, President and General Manager of the Bickford Drill & Tool Co., of Cincinnati, O., died March 2, of uremic poisoning, aged 35 years. He had been President of the company since 1898.

Prof. Henri Moissan, a noted chemist, died at Paris, France, Feb. 20, after an operation for appendicitis. He was born at Paris in 1852, and was educated at the Museum of Natural History. He became connected with the School of Pharmacy in 1879, later becoming Professor of Toxicology and Mineral Chemistry. In 1887 Prof. Moissan received the Lacaze prize for his valuable experiments with fluorine. Last December he was awarded the Nobel prize for his experiments in the isolation of fluorine, his researches into its nature and his application of the electric furnace to scientific uses. In 1893-94 he succeeded in artificially producing diamonds by the sudden cooling of molten iron or silver impregnated with carbon. He also devised a method for simplifying the production of acetylene gas, and had published many articles on the results of his researches.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 19-21. Annual Meeting at Chicago, Ill. Secy., L. C. Fritch, 1562 Monadnock Block, Chicago, Ill.

IOWA ELECTRICAL ASSOCIATION.
April 18-19. Annual Meeting at Clinton, Iowa. Secy., L. B. Spinney, Iowa State College, Ames, Iowa.

THE AMERICAN RAILWAY ASSOCIATION.
April 24. Annual Meeting at Chicago. Secy., W. F. Allen, 24 Park Pl., New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 22-24. Annual Meeting at New York City. Secy., W. H. Merrill, 382 Ohio St., Chicago, Ill.

THE ENGINEERS' CLUB OF PHILADELPHIA.—A regular meeting of the club will be held Saturday evening, March 16, when Prof. Gellert Alleman will read a paper on "Modern Methods Employed for the Preservation of Timber Against Decay and Teredo; Statistics of Consumption, Technology, Cost and Conditions Justifying Treatment."

BROOKLYN ENGINEERS' CLUB.—A regular meeting will be held at the Brooklyn Library Building, 197 Montague St., March 14, at 8 p. m. Mr. William Andrews will read a paper illustrated by lantern slides, on "Compressed Air in Modern Engineering." The paper will give a short resume of the history of compressed air, a description of air compressing plants in New York City and a description of the electro-pneumatic switch service at the Boston Terminal Station.

SOCIETY OF CHEMICAL INDUSTRY.—A meeting of the New York Section will be held at the Chemists' Club, 108 West 55th St., New York City, March 22, at 8.15 p. m. The papers to be presented are as follows: "Industrial Chemistry at Pratt Institute," Mr. Allen Rogers; "The Manufacture and Properties of Nitro Starch and the Use of Nitrogen Pentoxide for the Preparation of Nitro-Glycerin and Mannitol Nitrate," Messrs. A. Hough and A. Moscovici; "The Practical Application of Furnace Construction Theories, and the Practical Difficulties in the Way of Realization of Said Theories," Mr. Geo. L. Prentiss; "Notes on the Treatment of Chrome Sores," Mr. H. S. Riederer; "A Review of Recent Literature Respecting Asphalt," Mr. S. F. Peckham; "Solubility of Potassium Permanganate," Mr. Edward C. Worden.

ENGINEERING LITERATURE

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EDITORIAL.

Few engineers have the money and none have the time that would be required to buy and read the scores of engineering and other technical journals and the numerous society proceedings of the day. Some make little attempt to keep up with the vast flood of technical literature flowing from the press each week, but most engineers would really like, if it were financially and mentally possible, to make sure that nothing of real importance to them escapes their notice. In recognition of this desire a monthly journal called "Technical Literature" (220 Broadway, New York City) was started at the beginning of the present year. From the salutatory and from the first three numbers, it appears that the aim of the new journal is to present, in so far as it may be done by a single magazine, reprints and condensations of the articles of most general interest that appear in the American and foreign technical press. In addition, a classified descriptive "Index to Current Technical Literature" is published each month, together with book reviews and announcements, various news items, and original articles, both editorial and contributed, on various phases of technical literature. No other one paper is devoted wholly to the field selected for "Technical Literature." The new journal far surpasses any other in the number, length, variety and general interest and pictorial embellishment of its articles reprinted or condensed from its contemporaries. The mechanical make-up and general appearance of the new journal is highly commendable. In conclusion, it seems only fair to "Technical Literature" and to Engineering News, and particularly to the readers of each, to state that the two journals are entirely independent of each other, although the editor and publisher of the new venture is the son of the founder of Engineering News, and for some time has been, and still is, connected with this journal.

We note the birth of a new foreign technical journal, "Der Eisen-Konstrukteur," published at Hamburg, Germany. Its field is roughly blocked out in a subtitle as follows:

> International special organ for iron building and bridge construction, transportation devices, the crane and cableway industry, loading machinery, etc., steel structures for mine plants, railway construction, shipbuilding, reinforced-concrete work, etc.

It seems to be intended primarily as a journal of structural steel work, and as such is the first of its kind, so far as our knowledge extends. Its ultimate vitality or usefulness can, of course, not be judged at so early a period, but is somewhat questionable in view of the fact that the field is fairly well cared for in various other journals of broader scope.

There has been a great activity in specialization of engineering or semi-technical periodicals in Germany within the past few years. Indeed, in respect to such specialization that country is quite unique. Some of the journals in the engineering field which have been begun in the last few years specialize in individual fields as follows:

> Turbines.
> Preservation and Care of Monuments.
> Quarrying and Sand Production.
> City Planning.
> Governmental Building Regulation.
> Reinforced Concrete.

One may wonder with good reason where this movement is to end, or rather how far it will go and to what extent the event will justify it.

CORRESPONDENCE.

Concerning Directions for Binding Volumes of Technical Journals.

Sir: I suggest that it might be a good idea to publish carefully made up specifications or directions for binding Engineering News, both by volumes and by years. My own unsatisfactory experience in having this done since 1890 caus[illegible] me to make this suggestion. The ordinary book binder seems to exercise more originality than judgment in this work.

The make-up of the paper might possibly be improved if the idea of binding it was kept in view. A great part of the value of the paper consists in having it bound for a reference book. My own preference is to bind it by years, and the great majority of bound volumes I have seen in the possession of others is bound in that form. The half-yearly volume can be stripped of advertising and carried in temporary binders.

Inset sheets seem to be a particular stumbling block to the binders, being usually sewed in and the central part thereby made invisible. This is varied by pasting in one edge of the sheet, so that in the process of trimming the volume the fold of the inset is cut, leaving one-half as a loose sheet and the central portion of the inset gone. Binding directions printed on insets might help this.

I also think that indexes for the Engineering Literature Supplement and Construction News Supplement should be printed separately, so they could be filed or bound with the supplements. As the supplements are paged separately they evidently do not belong in the regular matter, which is paged consecutively. My own preference is very strongly for yearly volumes, both for convenience and to save cost in binding.

Yours truly, O. W. Childs.

City Hall, St. Louis, Mo., Feb. 5, 1907.

[A year's issue of Engineering News makes a very unwieldy volume. In our own office the experience is that the bindings even of the half-yearly volumes last only a short time—sometimes not over three months, and not over a year in the average—before they are so dilapidated that complete rebinding is necessary. Mainly for this reason, we believe that the present plan of subdividing the year into two volumes of six months each is the best. It is open to individual preference to bind the full year's issue in a single binding, although the index will then be in two parts. There is a good argument for binding the Construction News Supplement separate from the remaining pages, which would seem to require a separate index; this will receive our consideration in closing up the present half year's volume. Concerning the Engineering Literature Supplement, however, we do not favor a similar course. After beginning with separate paging, this supplement was later, as now, paged consecutively with the reading pages of the regular issue. The contents of this supplement are permanently an integral part of Engineering News, and should appear in the bound volume in their regular place. There may be special cases in which it may be desirable or necessary to bind the Engineering Literature Supplement separately, but in our opinion these are exceptional.

We welcome the criticism and comment contained in the above letter, and make it public to stimulate helpful criticism from others. Our experiences with bookbinders have been just as troubled as those of Mr. Childs, so that we are able to extend our sympathy.—Ed.]

REVIEWS.

A New Book on Reinforced Concrete.

Reviewed by ARTHUR N. TALBOT.*

CONCRETE AND REINFORCED CONCRETE CONSTRUCTION.—By Homer A. Reid, Assoc. M. Am. Soc. C. E., Assistant Engineer, Bureau of Buildings, New York City. New York: The Myron C. Clark Publishing Co. Cloth; 6 x 9¼ ins.; pp. 884; 715 illustrations in the text and 71 tables. $5, net.

The table of contents of this 4-lb. book is so attractive, so logically arranged, and so well proportioned, that one is anxious to test the long menu set before him. Many books on reinforced concrete have been issued, and the author of a new book now has an opportunity of adopting the good features and avoiding the defects of the older books; and, for the same reason, the standards of excellence of the reader have risen and he will not ignore in a new book what he overlooked in the old. Some engineers may object to this book as being bulky and encumbered with pages of useless matter. Others will welcome the variety of data, formulas, and designs as giving a breadth of view. But as the data must be obtained from a great variety of conditions of fabrication and testing and must have been interpreted from varying view points, the results are not always comparable; and without very full explanation readers may be confused and misled, instead of enlightened. Some readers would prefer a few well-chosen formulas. Others may object that the designs are not critically discussed and that some poor designs are included among the good.

The book is divided into 34 chapters. The subject matter may be grouped as follows: Cement and its manufacture and tests, the aggregate, proportioning, mixing and placing concrete, cost of work, and finishing concrete surfaces, 132 pages; physical and elastic properties of concrete and steel, 85 pages; principles and styles of reinforcement, mechanical bond, curved pieces subject to flexure, and columns, walls and pipes, 53 pages; theory of flexure of beams and strength of columns with formulas and calculations, 136 pages; foundations, 58 pages; general building and construction and matters connected with practical construction, 142 pages; retaining walls, dams, conduits and sewers, tank and reservoir construction, chimneys, tunnels, etc., 144 pages; bridges, arches, piers and abutments, 104 pages; concrete building blocks, 20 pages.

Although the title is "Concrete and Reinforced Concrete," it is evidently intended that the book shall treat mainly of reinforced concrete, and, therefore, the space given to constituent materials and to proportioning and fabrication is limited. Bearing in mind such limitation, it may be said that the selection of material for presentation is, for the most part, well made. Little is given on actual requirements for cement, and no attempt is made to cite standard specifications. Many of the details of cement testing are not considered. Although in several places, under proportioning mortar and concrete, use is made of the amount of voids in the sand, and although different methods of determination give quite divergent results, no reference is made to the method to be used in determining the voids. In other ways, it is quite apparent that the treatment of constituent materials and of proportioning concrete was not intended to be exhaustive. The pages given to mixing and placing concrete and to finishing concrete surfaces are generally satisfactory.

The chapters on physical and elastic properties of concrete contain much valuable matter. Retempering, freezing, waterproofing, effect of sea water and of oil, preservation of metal, shrinkage and expansion, fire-resisting qualities, bond resistance, and strength and elasticity are included in these. Naturally a collection of data

*Professor of Municipal and Sanitary Engineering, and in charge of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.

on the physical porperties of such a material as concrete will include results obtained under very diverse conditions; their value would be enhanced by a more complete statement of the conditions under which the tests were made. Evidently the results for compressive strength and elasticity were taken from tests of cubes, but the author in another place discredits such tests as not being representative of the real compressive strength. In the opinion of the reviewer, many of the values for the compressive strength of concrete and the modulus of elasticity given in the tables and recommended for use are altogether too high for the conditions of ordinary building construction and should not be accepted as a basis for design. One wonders what foundation there is for the statement that concrete in compression has a fairly well defined point of elastic limit. Possibly the author has in mind some other than the ordinary definition of elastic limit. Some of the statements of the properties of concrete are apparently conflicting. In one place results of tests at the Massachusetts Institute of Technology are quoted as showing that the shearing strength is more than half as great as the compressive strength, and on the same page 40 to 75 lbs. per sq. in. is given for the allowable working shearing stress. Shear, longitudinal shear, and vertical shear are used very loosely. While the slip of a bar in concrete partakes of the nature of shear, it does not tend to clearness of statement to use the term longitudinal shear to mean bond resistance or bond stress, and longitudinal shear in beam action is quite another matter. Again, a distinction should be made between the bond developed on a bar and the necessity for reinforcement in the web of the beam. It is not true that mechanical bond lessens the need for resisting diagonal tensile stresses, as the author states, and the presence of stirrups does not decrease the amount of bond stress developed on the longitudinal reinforcing bars, nor the need for adequate bonding. The whole treatment of bond, shear and web reinforcement needs revision. The diagram for lines of stress in a beam under flexure, attributed to Rankine, is not enlightening, since it is applicable only to homogeneous beams and, besides, there is no explanation to show that the lines do not represent equal stresses. Some further word of caution should be given concerning the impracticability of anchoring the ends of rods in such constructions as are illustrated in the diagrammatic representations on pages 221-223, as well as for the cable-suspension-bridge floor illustrated in another place.

The analytical or theoretical portion of the book is its weakest feature. The author has quoted much valuable matter from various writers, and the variety of treatment and diversity of symbols and formulas given will at least allow the reader a considerable freedom of choice. Of course, something may be said in favor of continuing the practice of giving a long list of formulas, even although if properly interpreted and consistently used the results do not vary greatly. It is unfortunate that the formula for strength of beams which the author recommends and adopts for use in the only working tables given is based upon an improper relation between modulus of elasticity and stress, or else that it is improperly used in the example cited. To use a full parabola regardless of the amount of deformation developed is not logical, but the greater inconsistency in the author's treatment lies in the use of the same value of the modulus of elasticity as is ordinarily quoted for concrete, instead of one one-half as great. Although the author states in a remote place that the value of the modulus of elasticity should be chosen to fit the conditions of the parabola, yet all the references to data and the illustrative examples used go to show that the author intends that the ordinary modulus of elasticity shall be used. As a matter of fact, to get what the author evidently intends, in using the tables on pages 305 and 306 the reader should select a value of the ratio of e twice that found by using the moduli quoted by the author. In the particular example cited a modulus of elasticity consistent with the analysis used in the derivation of the formula (ratio 20 instead of 10) will give 25% more strength than that used. This oversight is not a new one; the error persistently stays in reinforced concrete literature. Attention should also be called to the fact that in the examples calculated by the author, in the tables, and in other formulas quoted, the strength given for the beams of a medium amount of reinforcement is very low, due to limitations put upon the compressive resistance of the concrete. Many experiments have shown that with ordinarily good concrete, a 1% reinforcement will not develop anything like the full strength of the concrete. Beams having as much as 1½% or even 2% reinforcement may not fail by compression in the concrete. It is generally understood that the compressive strength of concrete is not the controlling element until a point is reached considerably above that given in the author's tables. It is time that our formulas and constants take into consideration the peculiar conditions attending compression in beams.

The treatment of web stresses and web reinforcement is not satisfactory. The author seems to misapprehend the nature of the stresses and the purpose of web reinforcement. He confuses shear and bond. He attributes failures along the plane of the upper side of the reinforcing bars to longitudinal shear. He states that stirrups are used to prevent horizontal shearing, and tries to compare the action with that in a plate girder. The nearest approach to a reasonable solution is that given for shear and stirrups under Hennebique's formula for T-beams. This defect seems the more noticeable as so many of the examples of girders, footings, piers, retaining walls and cantilever beams given in detail elsewhere have web reinforcement of some kind, and no study or discussion is made of this feature of the construction.

Columns are fairly well discussed, but it is difficult to understand why, for columns exceeding 20 to 25 diameters, the author uses Euler's formula for long columns, unless he considers that such columns will bend like long lath in a series of waves. Such an explanation, however, is in conflict with the author's use of $\frac{1}{12}\ bd^3$ as the moment of inertia of the concrete, for this use implies a tensile stress in the concrete equal in amount to the maximum compressive stress (a matter which he must have overlooked), since in Euler's formula the direct effect of the compression caused by the load is not considered. The absurdity of using Euler's formula for such columns may be seen in the fact that for a square column of 30 diameters' length and 17 reinforcement the author's formula gives an average stress of over 11,000 lbs. per sq. in. on the concrete. Evidently, the column in which stiffness and not strength controls will be many times as long as this column. Clearly, for a long reinforced concrete column of any length likely to be used in building construction a formula of the form of Rankine's, which takes into consideration the compression due to the load, should be used and not Euler's. The treatment of hooped columns is good, if some apparently contradictory statements are excepted, and there is a fair presentation of the available data and of present knowledge on the subject.

What has been said about the theoretical and analytical portion of the book has been given thus at length for the benefit of the reader who may not be sufficiently informed to differentiate the good from the bad, and not for the purpose of disparaging the book, for many of the faults here referred to are found in most books on the subject. On the whole, with a few important items to be excepted, the analytical treatment is more complete than that in other books which have appeared. The author missed an opportunity of doing a great service to the engineering profession by not giving a strong, clear-cut and adequate treatment for use in the design of structures. By this is meant not long formulas nor merely the calculations for a simple beam without end restraint. The distribution of floor loads to girders and columns, the limits of the amount of restraint which may be counted on in floors and girders, and the precautions to be taken in the calculation and design on account of the existence of such limits; the stresses brought on restrained beams by virtue of the bars being carried from lower to upper side of beam (particularly the bond stress); the bond and anchorage needed in the cantilever beam construction of foundations, piers and retaining walls; calculations for web reinforcement; these and a variety of other matters need consideration. This might well be followed up with a critical study of the design of representative structures, the reasons for the assumptions made in the calculations, and a discussion of the merits of the designs. Accustomed as engineers are to designing in steel, they are likely to overlook many features of a composite construction in which essential differences in calculation exist by virtue of the very low tensile strength in the concrete and the necessity for bond and anchorage. Defects along such lines are apparent in a number of the designs given in the text. A treatment of the kind suggested would necessarily be limited in extent, and its introduction of course would, on account of limitations of space, bar out matter now included.

The portion of the book dealing with structures and descriptions and illustrations of structures merits commendation. The treatment of foundations, including piers and piles, is excellent. The chapter on general building construction contains more than one hundred pages giving well-selected plans and details of columns, girders and floor systems of buildings, and is an especially valuable chapter. A variety of types and methods is illustrated. The author's plan of giving only descriptions of structures and methods of construction is broken into on page 526 by a discussion on continuous beams and slabs; and among other things the slip is made that for a beam fixed at the supports the bending moment at the center of the beam is $\frac{1}{12}\ wl^2$, instead of $\frac{1}{24}\ wl^2$. Under Practical Construction, matter relating to forms for use in concrete construction is given quite at length, and many details of construction are discussed. Apparently nothing is given on so important a matter as the time of removing forms and centers, and the index contains no reference to it. Many examples of retaining walls and dams are given, but the strength of the connections in some of the designs may be questioned. Considerable space is given to conduits and sewers and to tank and reservoir construction, and the illustrations are well selected. Again one wishes for an analysis of the stresses and a critical discussion of the merits of the various examples, for although a chapter is devoted to curved pieces strained in flexure no values are given for the bending moment developed in any other form of member than a straight beam. The chapters on bridge construction, arch bridge centers, and methods of construction and bridge piers and abutments contain a well-selected lot of examples of structures and much valuable information on types and methods of construction, and form one of the strong points of the book.

An index covering ten pages seems to be fairly complete. The typographical and illustrative features of the book are excellent; a clear, well-printed page and well-drawn and legible cuts form an attractive feature. The publisher will receive the thanks of book buyers for keeping the price reasonably low.

The general plan of the book is excellent, the proportioning of parts good, and the manner of presentation commendable. It may seem ungracious to suggest corrections and revisions while the author still has in mind the enormous task involved in the preparation of a book of the scope and magnitude of this, but excellence in technical books is secured only by long and repeated effort. In some minor particulars objection may be made to the exact order of presentation, and some headings and forms of statement need editing. Changes of this sort will doubtless be made when a new edition is printed. The criticisms made of the analytical treatment (the mechanics of the subject) indicate that improvements in this direction may well be made. The book as a whole is a valuable one and deserves to rank among the standard works on

concrete and reinforced concrete. In the treatment of the constituent materials, of methods of proportioning, and of the qualities of concrete it does not attempt the thoroughness and completeness of Taylor and Thompson's "Concrete" or Sabin's "Concrete." In reinforced concrete it does not enter into some of the field occupied so well by Marsh's "Reinforced Concrete." It covers much the same ground as Buel & Hill's "Reinforced Concrete," and the two may be said to be competitors for the patronage of American engineering readers interested in the general phases of reinforced concrete construction.

How to Burn Soft Coal Without Smoke.

Reviewed by WILLIAM KENT,* M. Am. Soc. M. E.

COMBUSTION AND SMOKELESS FURNACES.—By Jos. W. Hays. New York: Hill Publishing Co. Cloth; 6 x 9½ ins.; pp. 104; 15 illustrations in the text. $1.50.

This is a concise and clearly written treatise on the subject of combustion of soft coal, and furnaces for burning it without smoke. It is a timely book, on account of the great interest now being shown in many cities in getting rid of the smoke nuisance. The material it contains is not new to the engineer, but it may be of service to the layman, and, especially, to members of city councils and others who are wrestling with the smoke problem. The book starts in with a theoretical discussion of the nature of heat, which might well have been omitted, and also "The Mechanical Equivalent of Heat," which has nothing to do with the subject of the book. It also contains a serious error, in stating that the difference between the figures for the mechanical equivalent of heat, 772, found by Joule, and 778, by Rowland, was due to the fact that Joule's experiments were made at Manchester and Rowland's at Baltimore—the force of gravitation differing in the two places. The fact is that the force of gravitation in the two places differs only by about one part in 800 instead of six parts, and Rowland's figure is practically accepted universally by modern writers, instead of Joule's. The theoretical part of the book, treating of the chemistry of combustion, contains practically the same matter as is found in other treatises on the subject.

An excellent statement is made about the two things that are absolutely necessary for the complete combustion of bituminous coal and the gaseous elements, as follows:

> 1st. The introduction of air in the proper quantity, and at the right times, and in such a manner that the oxygen contained in the air will freely mingle with the gases as fast as they are distilled, and promote combustion.
>
> 2d. The maintenance of the gases at or above their igniting points, until they are completely consumed or oxidized.

The author emphasizes strongly the advisability of regulating the supply of air entering the firebox, with hand firing, so that the greatest quantity of air is admitted immediately after fresh coal is fired and the supply diminished after the volatile matter has been driven off. It is to be regretted that the author has confined himself to general statements on this matter, and has not given any figures to show how much air should be admitted immediately after firing, and at what rate it should be diminished. It is probable that the amount would differ with different coals, according to whether the coal was a coking coal or not and whether it gave up its volatile matter readily or slowly, or whether the coal contained much or little moisture. On page 39 the author illustrates the ordinary setting of the inclined water tube boiler, and clearly explains that it is the worst possible kind of a setting for this kind of boiler, when using soft coal. It is greatly to be desired that this fact should be more commonly known. He shows also the "Dutch Oven" setting, and explains its advantages—referring, however, to what he considers a great disadvantage, that "it is always a clinker-maker and gives the fireman a taste of the Inferno." The author does not seem to be aware of the fact that the fireman can handle a "Dutch Oven" furnace as easily as any other, if he learns the trick of putting the first shovel of coal, at each firing, near the deadplate. This will cool the fire immediately in front of him, and the smoke arising from it makes a curtain to shield him from the intense heat of the rear of the furnace. Clinker can also be prevented by the introduction of a little exhaust steam under the grate bars, and, if formed when very bad coal is used, it can be handled by the use of shaking grates.

*Dean of College of Applied Science, Syracuse University, Syracuse, N. Y.

The latter half of the book is devoted to the discussion of smokeless furnaces. The author classifies them into mechanically-fired furnaces and hand-fired, and subdivides each of them so that there are about fifteen sub-classes. He says the three prime requisites which should be borne in mind, when considering the merits of any smoke-consuming device, are: (1) a sufficient supply of free air in the fire-box and intermixed with the gases; (2) a sufficient temperature at the point and moment of ignition; (3) sufficient room for the expansion of the burning gases during the act of their combustion.

The author then takes up a description of the individual furnace-stokers and criticizes each one impartially. This book is different from every other one on the subject in this respect. Other books, in describing furnaces or other engineering devices, generally point out the good things and generously say nothing about the bad ones, but the aim of the author, as stated in his concluding chapter, has been "to carefully point out the undesirable features of every type of 'Smokeless Furnace' likely to be offered to the coal consumer."

In this wholesale impartial criticism, the author has done a good service to engineers who may be apt to overlook the bad points of a device if it is not especially called to their attention, but he has rather overdone the matter, so that the inexperienced reader might conclude from reading the whole book that all smokeless furnaces were bad, and that, therefore, none of them had better be tried. This line of reasoning, however, is equally applicable to almost any kind of machine. For instance, it might be said that all steam boilers are expensive, troublesome and dangerous, and that, therefore, steam boilers should not be used. All smoke-consuming furnaces are expensive, all will need repairs, and all require a higher degree of intelligence than the ordinary furnace, but these facts are no more to be considered as arguments against their use than the same facts are in relation to the use of Corliss engines, as compared with the old-fashioned, slow-running slide-valve engine. The advantages of a good smoke-burning furnace so far outweigh its disadvantages that they must eventually come into use, as soon as the public at large become sufficiently intelligent or well-educated to recognize their points of advantage.

The author is very severe in his criticisms of steam jets, and says that it is impossible for him to give honest views favorable to the steam jet. He says:

> The cost of supplying the steam to operate such a make-believe appliance is so great that the man who pays the coal bill could not afford its use if paid handsomely to permit the equipment of his boilers.

He then gives a long catalogue of objections to the use of the steam jet, most of which appear to be well taken. Exception may be taken to the statement that "escaping oxides of sulphur are converted into vapors of sulphurous and sulphuric acid." The only oxide of sulphur that escapes from the furnace is sulphurous acid, and this would escape whether a steam jet were used or not, and if it is converted into sulphuric acid by the action of moisture, there is enough moisture in the coal and in the air to effect this conversion in the absence of the steam jet. In fact, the conversion does not take place on the surface of the boiler itself, as long as the boiler is kept hot, but it does take place in the cold and is the cause of rapid rusting out of small iron chimneys.

The author even has an objection to the "alternate" system of firing. He says:

> It is evident that more air will be admitted as the fresh fuel approaches the coking point, where the demand for oxygen is small, than immediately after firing, when the demand is at the maximum. It is impossible to approach anything like correct air regulation with a furnace of this character.

The author should have added that, nevertheless, the errors of excess and deficiency of air are much less in the alternate system of firing than in the ordinary system. For instance, in the ordinary system, it is quite possible for the air supply to be 50% deficient, immediately after firing, and 100% in excess just before the next firing. Let the furnace be fired exactly in the same manner, but half of it at a time, alternately, and then, with a proper mixing device such as the wing-wall furnace, the result will be that the deficiency of air at the beginning is only 25%, and the excess at the end only 50%, or one-half of the excess that is found in the ordinary firing. Correct air regulation, however, can be obtained with the alternate system of firing, just as with any other system, by the use of an auxiliary device to regulate the supply of air as needed.

The concluding chapter of the book is an attack on what the author calls "the test delusion." He says:

> If the author can succeed in discrediting the "evaporation test," as an evidence of efficiency, he feels that he will have accomplished a service to engineering. Such tests may be made to prove anything desired; place no confidence in them. The above stricture is not intended to apply to the evaporation test as an evidence of boiler efficiency. Smokeless furnace literature is full of the reports of evaporation tests, purporting to show and prove increased efficiency.

The author's criticism undoubtedly applies to many evaporation tests that are published, but he goes too far in attempting to discredit all evaporation tests, when made to determine furnace efficiency. He says the proper test to apply to any device claiming to improve combustion is a flue gas analysis; also that: "Such analysis not only determines the extent of combustion, but the percentage of surplus air carried with the chimney gases." The fact is that a flue gas analysis is often as incorrect as an evaporation test is, and it is even more liable than a boiler test to lead to erroneous conclusions. Even if the analysis is made correctly, which it often is not, it shows the composition of the gas in the chimney after it has been diluted by infiltration of air through the walls of the boiler setting. The analysis, moreover, does not show that combustion is taking place properly in the furnace, for secondary combustion may be going on anywhere between the furnace and the chimney. Plenty of results of gas analysis have been published showing excellent figures, and yet they were obtained from furnaces which give off a great deal of smoke. The analysis does not determine the amount of unburned carbon escaping from the chimney, and generally it does not determine the amount of hydrogen or of carburetted hydrogen. The author himself could not tell from a gas analysis made by the Orsat apparatus whether the chimney was smoking or not, or whether it was giving off unburned hydrogen or hydrogen carbons. There are two tests to be applied to a smokeless furnace. One is the test of the observation of the smoke. The other is the test of economy, and, at present, there is no known way of finding the economy except by an evaporation test. The evaporation test, if properly made, is conclusive as to economical results produced by the boiler and furnace under the particular conditions of the test. Gas analysis is useful sometimes in showing the cause of bad economy; continuous gas analysis is especially useful in indicating to the fireman whether the air supply is correct or not, but by

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no means can gas analysis be substituted for an evaporation test as a measure of the economical work of a furnace. The author says nothing in his book about the use of the furnace pyrometer to indicate the action of the furnace. If the Fery radiation pyrometer, which is now being experimented with in physical laboratories, should prove to be a durable and reliable instrument its introduction would be more valuable in the study of furnace conditions than any flue gas analysis is likely to be.

Hydraulics.

Reviewed by GARDNER S. WILLIAMS,* M. Am. Soc. C. E.

A TEXT-BOOK ON HYDRAULICS.—Including an Outline of the Theory of Turbines. By L. M. Hoskins, Professor of Applied Mathematics in the Leland Stanford, Junior, University. New York: Henry Holt & Co. Cloth; 5¾ × 9 ins.; pp. 271; 127 illustrations, mostly in the text. $2.50.

The criticism of any text-book must be modified according to the capacity of the instructor who is to teach classes from it. For the use of those of experience and thorough training in the subject, a work giving the fundamental principles in a clear and concise form without elaboration is to be preferred, while for that of the less qualified instructor the treatise should be much more complete. So, too, if the book is to be used in the office by the inexperienced or those not technically trained, the requirement is substantially the same as in the case of a young instructor.

The work under consideration falls rather in the former than in the latter category, and may be said to present the time-honored facts and dicta of its subject in a concise manner, leaving to the instructor abundant opportunities to expand and elucidate; without such additions the material contained in it is hardly sufficient to afford a satisfactory training in Hydraulics. In these days the appearance of a new text-book on any subject should have for its justification something beyond revenue, and one naturally looks in the present volume for some new ideas or at least for the bringing of its contents down to date.

In general it may be said that the language employed is well chosen, but the use of the term *effective head* (p. 49) for the more common one of *total head* seems likely to be confusing. To the ordinary mind the term "effective" conveys the idea of that which is then and there capable of effecting something, and to say that the head which has already been used up in surmounting an elevation is at the summit *effective* seems rather a contradiction.

A discussion of the derivation of exponential formulae is presented, but the prime requisite of its application, that the original locus must pass through the origin, is nowhere mentioned; and the restriction of the exponential formula to post-critical velocity flow is difficult to explain.

On page 112 the statement appears: "In practical hydraulics velocities below the critical value rarely or never need be considered." Here the author evidently overlooks the important applications of his subject to the design of drainage systems for filters, and the flow of water through sands and gravels. The author pins his faith to Darcy's experiments and apparently ignores a number of equally well-conducted more recent ones which have added much of value to our knowledge. It is doubtful if any of the pipes used by Darcy represent such as are now usually met with, and in the interpretation of his experiments that investigator himself overlooked an important factor which recent experiment has established.

The author states in his preface:

> In the presentation of working rules for estimating flow in the various practical cases met by the engineer, it has been aimed in every case to give a clear statement of the rational basis of the formula adopted, and also to make clear to what extent the theory is defective and the formula therefore empirical.

In discussing Darcy's formula, however, the statement is omitted that it was based upon the incorrect theory that the distribution of velocities in a circular pipe is parabolic, and in dealing with Kutter's formula the author likewise fails to state that its supposed application to large channels was based upon a series of experiments long since removed from the category of reliability.

Some eight or more pages are devoted to Kutter's formula, regarding which it is stated that the formula "provides a rule applicable to cases for which otherwise there would be no guide whatever because of the lack of experimental data." It is true that the formula provides such a rule, but the effect of its application to such cases is well exemplified in the Chicago Drainage Canal, where a discharging capacity of 14,000 cu. ft. has been obtained in a channel computed for 10,000. Far more accurate results can be obtained with the exponential formulae, but a single example of the latter seems to the author unworthy of presentation.

In the portion of the book devoted to the flow of water over weirs the Francis formula is presented, but no sufficient directions are given for applying it to the case where velocity of approach is important. This is followed by a brief discussion of the Hamilton Smith, Jr., formula, and tables of his coefficients are given. The extensive and valuable work of Fteley and Stearns is not mentioned and the monumental series of investigations by Bazin are evidently unknown to the author, for he states on page 150 that "cases are rare in which measurements can be made with a degree of reliability warranting the use of formulas or coefficients claiming greater accuracy than those of Francis." The important matter of the method and place of observing the head is entirely overlooked.

In the chapter on the Dynamic Action of Streams the statement regarding the coefficient of different forms of impact openings for Pitot Tubes is in flat contradiction to the thoroughly reliable experiments of White, and the analyses and conclusions of the author betoken a lack of understanding of the real problem, to an extent that renders them positively misleading.

The book closes with six chapters on Water Wheels and Centrifugal Pumps. The same brevity of discussion is continued here that exists in the rest of the book, and the student will often have difficulty in following the argument. There is a notable lack of information upon practical details which, of course, may or may not be essential in a theoretical treatise.

As a whole it may be said that the book presents the laws and theories of Hydraulics as they were recognized 20 to 25 years ago. There is authority for most of its statements in the treatises of that time, but it can hardly be said to cover the field as we regard it to-day.

*Professor of Civil, Hydraulic and Sanitary Engineering, University of Michigan, Ann Arbor, Mich.

Errors in Bridge Design.

ON SOME COMMON ERRORS IN IRON BRIDGE DESIGN.—By W. C. Kernot, M. Inst. C. E., M. Am. Soc. C. E., Professor of Engineering, Melbourne University. Second Edition. Melbourne, Australia: The University. Cloth; 5½ × 8¾ ins.; pp. 70; many plates.

To know thoroughly what is wrong is the soundest basis for knowing how to do right—at least in engineering construction. One may acquire a colorless, lifeless knowledge of correct results and methods without learning anything of faulty construction; a good part of the teaching in engineering schools has this as its object and effect. But it is impossible to become thoroughly acquainted with bad construction or method, to learn definitely what is faulty and why it is so, without acquiring at the same time and as a derived matter a mastery of correct method. Professor Kernot has turned this idea to account in the field of steel bridge construction by writing the book above noted: an illustrated and annotated schedule of faults in both details and general design. The book cannot fail to be immensely helpful to the student, the beginner. But it has at least equal value for the practitioner, the engineer who designs steel work or may have occasion to judge it. Both classes of readers of the book will appreciate, besides the mere matter which it contains, the simple language and elementary reasoning employed.

A list of faults such as this book gives can of course hardly be made complete. In the present case there is no pretension to completeness, and indeed much is absent that one expects to find prominently noted. Thus, there is nothing said of weak connections of lateral bracing (as when a lateral rod is fastened by passing through the upturned leg of a small length of angle-iron), or of connecting floorbeams and laterals in pin-connected highway bridges to loose hangers, or of using tension bars for the end panels of the bottom chord even though traction stresses may reverse the tension. But since completeness is impossible, and since the points which the book does discuss are important ones, it is not to be criticized for the omission of this or that further fault. Moreover, the local conditions (Australian and Indian practice being most largely drawn upon for illustration) determine to a large extent the choice of matter. We are glad to note that the local conditions did not operate also to color the author's views of right and wrong practice, and that he takes a broad scientific standpoint throughout. British practice in favoring shallow, flexible girders and trusses, even where deeper ones give opportunity for much better and more appropriate lateral bracing, and in employing, even to-day, the totally irrational overhead arch strut for top lateral bracing, is openly criticized. Curved members are condemned, thus:

> * * the necessity of absolute straightness is an immediate consequence. Strange to say, however, owing to some peculiar warp of the human mind, many persons persist on fanciful grounds in increasing the cost and diminishing the strength of structures by the introduction of curved members.* * But * a chord curved at a large radius and divided into panels so short as to be practically straight, cannot be reasonably objected to.

The charge is made strongly that the care and maintenance of bridges is often "scandalously neglected," and in connection therewith certain specific recommendations are made. There is occasionally also a direct suggestion, not concerning existing bridges. Such a one is a suggestion for designing railings or parapets. The load of 100 lbs. per lin. ft., applied at the top, is advocated, and a safety-factor of not less than 3 for metal and 5 for timber.

One feature of the book deserves special commendation: the frequent citation of tests on models of special forms of construction. To show, for instance, that a column composed of two parallel members joined by cross-pieces is stronger when these cross-pieces form a triangle system (latticing) than when they are mere batten-plates, tests were made on models of four struts of similar section, with four styles of tieing, and the point was proved very obviously. The results of such tests, cited as proof of any particular criticism, aid materially in carrying conviction, not alone to the student reader, but equally to the "old hand."

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A British Book for Draftsmen.

Reviewed by HENRY S. JACOBY.*

NOTES ON CONSTRUCTION IN MILD STEEL.—Arranged for the Use of Junior Draftsmen in the Architectural and Engineering Professions, with Illustrations from Working Drawings, Diagrams and Tables. By Henry Fidler, M. Inst. C. E. London, New York and Bombay: Longmans, Green & Co. Cloth; 6 × 9 ins.; pp. 448; 425 illustrations in the text. 16s., net. American price, $5, net.

According to the preface it is the author's aim to aid the junior draftsman to bridge the gap between the stress sheet and a working drawing that shall successfully pass the ordeal of criticism in the shops during construction and in the field during the erection of the structure. His plan definitely excludes any computations arising out of the application of mechanics to design, although hints are occasionally given as to theoretic considerations.

The first chapter gives an elementary treatment of the physical and chemical qualities of mild steel as influenced by its composition and the various processes in manufacture. The second chapter describes the different rolled shapes and gives their mechanical elements, as in the manufacturers' handbooks. The third chapter opens with notes on the process of riveting. These are followed by the dimensions of standard rivets, after which there are given some details of riveted work. These include such examples as the bracing between a pair of cast iron cylinder piers supporting a plate girder bridge, its solid floor system, plate girder runways for traveling cranes, parts of lattice girders for roofs, and of beam supports for shallow cast iron water tanks on roofs. Full details of the castings for the piers and tanks are also given. In the plate girders one sees a characteristic difference between English and American designs. Each web stiffener is bent outward when it reaches the flange angle and is then bent again to engage one rivet through the cover plate beyond the flange angle. Accordingly, the stiffeners do not support the flange angles directly, as in American practice.

The first part of the fourth chapter gives a summary in graphic form of some of the principal experiments on columns of wrought iron and steel made in England and America. Special attention is called in the text to the difference between the theoretical and the practical column, and the reader receives the impression that the ultimate resistance of practical columns forms the basis for their design. It is to be regretted that no thorough discussion of this subject is given. Since columns are not expected to be stressed beyond the elastic limit it is irrational to attempt to derive their safe strength from tests to destruction. The latter part of the chapter shows a series of steel column sections ranging from the single bar or angle to the most complex design with eighteen rows of rivets; followed by detail drawings of column bases, connections of beams to columns, and the construction of several special columns to support crane runways as well as roof trusses.

The fifth chapter contains notes and illustrations of roof construction, including details of riveted trusses and of cast iron gutters, pipes and ventilators. It is surprising to see the extent to which tee shapes are used; in this country they are never used for any truss member. The sixth chapter deals with the use of mild steel and iron in marine engineering, including examples of iron piles, cylinder piers, and caissons for breakwaters and for closing dock entrances. The seventh chapter contains 13 pages on the protection of steel surfaces from corrosion.

While many useful hints are given to the designer regarding various details as influenced by practical conditions, some are very general and indefinite in character. The range of illustrative examples seems to be too narrow to accomplish the author's purpose. A comparative discussion of different details used for similar structures would materially enhance its value to the young designer or draftsman. In this respect the latter part of the chapter on columns is decidedly the most valuable.

The fact that this book forms a part of a series doubtless accounts for its physical make-up, and consequent cost. The illustrations in most cases might have been advantageously reduced, some of them to one-third the present size, linear measure, provided the lettering were properly proportioned. The paper is very heavy and the margins wide, thus making the book bulky and inconvenient to handle. To American designers who are accustomed to the excellent manufacturers' hand-books of pocket size, printed on fairly thin paper, it must seem that a book of notes on details of construction should have a similar form for convenient use in the drafting room.

SWITCHBOARDS.—For Power, Light and Railway Service—Direct and Alternating Current—High and Low Tension. By Wm. Baxter, Jr. New York: The Derry-Collard Co. Cloth; 5½ × 8 ins.; pp. 192; 150 illustrations, mostly in the text. $1.50.

This book, we believe, is the only one for sale at the present time which is devoted entirely to switchboards. The subject of switchboards has, however, been quite fully covered in standard treatises on electric lighting and allied subjects, but heretofore it seems to have been the general opinion that there was not a sufficient demand for a book treating of switchboards, alone, to warrant its production. Switchboards for different kinds of electric service, outside of telephone work, are considered in the present volume.

In the first third of the book the way in which switchboards are connected for single generator and multiple generator plants, and also for the three-wire system, is shown. The diagrams given are, in the majority of cases, imaginary ones, but the author has succeeded in arranging them so as to present the subject in a clear light and so as to indicate as far as possible the modifications required to meet given conditions. In this part and in the following portion of the book the style is extremely simple and clear, and the average switchboard student or attendant should find no trouble whatever in following the text and illustrations.

Somewhat over a third of the book following the matter just mentioned is devoted to switchboards in actual practice. Here are shown and described a number of different forms of switchboards for direct-current and alternating-current practice in power, light and railway service of both high and low tension. Considerable space in this section is devoted to the construction of switchboards.

A few switchboard instruments are discussed (for example, a synchroscope and a ground detector), but no description is given of voltmeters, ammeters, or wattmeters. A book of so elementary a character in other respects as is this one should have covered these important details. With the exception of this omission and one other noted later on, the book is an ideal one from a didactic standpoint.

The remaining portion of the volume is devoted to switches, circuit breakers, and lightning arresters. These respective subjects are treated in an interesting and instructive manner. The only remaining criticism we have to offer is that the value of the book would have been greatly enhanced by a chapter on the operation of switchboards, and also one on the proper location of switchboards with respect to other apparatus in a station.

CONTRIBUTIONS FROM THE SANITARY RESEARCH LABORATORY AND SEWAGE EXPERIMENT STATION.—Massachusetts Institute of Technology, Boston. (Prof. W. T. Sedgwick, Director.) Vol. III. Reprinted Papers. Boston, Mass.: The Institute. Paper; 6 × 8½ ins.; illustrated.

Most of the papers here reprinted relate to some phases of sewage treatment. The leading paper, however, is on "The Readjustment of Education and Research in Hygiene and Sanitation," and was presented by Prof. W. T. Sedgwick to the 1905 meeting of the American Public Health Association. Other papers deal with public water supplies and typhoid fever, and with various phases of copper sulphate treatment of water and sewage. The bringing of these scattered papers together will be welcomed by many.

*Professor of Bridge Engineering, Cornell University, Ithaca, N. Y.

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Producer Gas.

Reviewed by ALFRED E. FORSTALL.*

PRODUCER GAS.—By J. Emerson Dowson, M. Inst. C. E., M. Inst. M. E., and A. T. Larter, B. Sc. (London), F. C. S., Associate of the City and Guilds of London Institute. London, New York and Bombay: Longmans, Green & Co. Cloth; 5¾ x 9 ins.; pp. 295; 73 illustrations in the text, and numerous tables. 10s. 6d., net; American price, $3, net.

The name of Dowson being as inseparably connected with the manufacture and use of producer gas in gas engines and ordinary industrial furnaces as is that of Siemens with its use in the manufacture of iron and steel, a book on producer gas of which Mr. Dowson is the principal author is naturally opened with the expectation that it will be found to treat the subject thoroughly and well. The book now under review fully meets this expectation.

It begins with a very good discussion of the theory of producer gas, which treats of the composition of the best gas theoretically obtainable both without and with the use of steam; shows the advantages derived from this use through the reduction of the temperature in the producer and the production of a gas of greater calorific value per unit volume; gives a comparison between the theoretical possibilities and the results obtained in practice; describes the reversible reactions that occur between carbon, oxygen, hydrogen and steam during the formation of producer gas and the influence upon the final composition of the gas, of the conditions, of temperature, depth and physical condition of fuel, and the rate at which steam is used, which obtain in the producer. This discussion is very well written and gives a very clear idea of the conditions required for the attainment of the best results in practical working.

The use of producer gas is then taken up, and after giving descriptions of several types of pressure producers, and of furnaces in which the gas is used, the application of producer gas to engine work, including the special treatment required by the gas when it is to be used for this purpose, is considered.

Suction producer plants are then treated very fully, descriptions of several forms of these plants being given with details of tests of plants using anthracite and coke and a comparison between these tests and similar tests of pressure plants. The effect upon the power developed by the engine, of the lower pressure in the cylinder at the end of the charging stroke, which is unavoidable with suction plants, is fully treated, and the necessity of having the gas connections from producer to engine of ample size and free from sharp turns pointed out. The necessity for good automatic regulation by which the amount of steam passed through the fuel bed is accurately proportioned to the load upon the engine when this is variable is also discussed.

A chapter, devoted to the use of bituminous coal, gives descriptions of the Mond producer and of various producers employing downdraft, or combined up and down-draft, for the purpose of doing away, as far as possible, with the production of tar.

Two very interesting chapters, one on stand-by losses of producers as compared with those of steam boilers, and the other giving a comparison between gas and steam power, are followed by chapters on fuels in general, their analysis and the determination of their calorific values.

Under the title "Practical Notes," the last chapter takes up, among other things, carbon monoxide poisoning and its treatment, the depth of fire to be maintained in the producers, the use of test flames, showing the quality of the gas, as a check upon the working of producers, and the precautions to be adopted before entering a holder when it is necessary to repair it after it has been used.

In an appendix is given information as to the various physical and chemical properties of the constituents of producer gas which are involved in its use for fuel purposes.

It is evident all through the book that the authors are thoroughly conversant with the actual working of apparatus for both the production and use of producer gas, and their book meets the needs of persons handling such plants better than any of the other books on the subject with which the reviewer is acquainted.

*Consulting Engineer, late Secretary American Gas Light Association, 58 William St., New York City.

MODERN PRACTICAL CARPENTRY.—For the use of Workmen, Builders, Architects and Engineers. By George Ellis, Author of "Modern Practical Joinery," etc. London, England: B. T. Batsford. New York: The Industrial Publication Co. Cloth; 7 x 10¼ ins.; pp. 390; folding and other plates and numerous text illustrations. $5, net.

To an engineer or contractor engaged in the execution of any large construction project the services of an intelligent carpenter's foreman are invaluable. It is a regrettable fact that such a man is hard to get. The average carpenter is a good workman so far as the purely mechanical side of his trade is concerned, but men who can lay out work, read drawings and make drawings of a minor nature are few and far between. There seems to be no good reason why a carpenter should not take the trouble in his younger days to study some of the theory of his trade so that he can rise to something higher than the mere journeyman.

As an aid to such study the above-named volume should be of great value. The author is an English carpenter by trade, and the book is a practical discussion of the methods and practices connected with the heavier kinds of carpentry work. It treats of the subject as seen in England, where wood work is used to a much greater extent than in this country. However, the discussions on shoring, scaffolding, tunnel and bridge centering and coffer dams are of universal interest. It is to be regretted that a chapter on concrete forms was not added. There is in the book a large amount of matter of purely academic interest in regard to domes, steeples, decorative roof-trusses and other fancy carpentry work, which is of no practical value to an American carpenter, who is rarely called upon to do any such work.

A discussion of the theory of the strength of materials is appended, which, while not entering into the mathematics of the subject, is sufficient to enable one with no advanced mathematical knowledge to understand the methods of designing beams.

EVAPORATION LOSSES IN IRRIGATION AND WATER REQUIREMENTS OF CROPS.—By Samuel Fortier, Irrigation Engineer in Charge of Pacific District, Irrigation and Drainage Investigations. Bulletin 177, Office of Experiment Stations; A. C. True, Director. (Work done in cooperation between the Office of Experiment Stations of the U. S. Department of Agriculture and the State of California.) Washington, D. C.: Pub. Doc. Paper; 5¾ x 9 ins.; pp. 64; 2 plates and 19 text figures.

Some very interesting and suggestive experiments on evaporation losses from the soil are reported in this bulletin. The tests were made with double tanks, water-jacketed, set in the earth so that their tops would be level with the ground. The inner tanks were filled with soil and were provided with bales for use in lifting and weighing. The tanks were lifted by means of a pulley and tripod. In one set of experiments a weighing scale was placed between the pulley and the bale, and in the other experiments platform scales running on a track were used. Among the specific subjects receiving attention were the effect of cultivation or stirring the surface, and of mulches, and also the application of the water in furrows and beneath the surface, upon the amount of evaporation. Deep furrows, with water applied for a long period at unusually frequent intervals, gave particularly good results. Subirrigation would be a very economical means of applying water, if practicable.

PASSAIC RIVER FLOOD DISTRICT COMMISSION.—Report, Dec. 1, 1906. (Richard Morrell, President, Passaic, N. J.) Paper; 6 x 9¼ ins.; pp. 79; folding and other plates.

In continuation of previous studies, the Commsion here submits plans and estimates for a dam across the Pompton River at Mountain View. A detailed report by Mr. Charles S. Gowen, M. Am. Soc. C. E., Consulting Engineer to the Commission, is included, together with a legislative bill authorizing the construction of the dam and reservoir. Detailed estimates of the benefits that would accrue to owners of property subject to floods, if floods were prevented by the construction of the proposed dam, are also submitted. The theory of the Commission is that a dam across the Pompton, creating a reservoir receiving the flood water of the Pompton, would effectually prevent floods on the Passaic below the junction of the Pompton therewith, and would also lessen the flooding of the meadows above the junction. The normal condition of the proposed reservoir would be empty, the reservoir gates being closed only during the flood flow of the stream.

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Extract from an address by H. WADE HIBBARD

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Walschaert Valve Gear.

Reviewed by ARTHUR M. WAITT,* M. Am. Soc. M. E., M. Am. Soc. C. E., Assoc. Am. Inst. E. E.

THE WALSCHAERT LOCOMOTIVE VALVE GEAR.—A Practical Treatise on the Locomotive Valve Actuating Mechanism Originally Invented by Egide Walschaert; with the History of Its Development by American and European Engine Designers, and Its Evolution into the Mechanically Correct Locomotive Valve Gear of the Present Day. By W. W. Wood, Air Brake Inspector. New York: The Norman W. Henley Publishing Co. Cloth; 5 × 7¼ ins.; pp. 193; 71 figures, partly in the text. $1.50.

This treatise on the Walschaert Valve Gear, which has of late sprung into prominence as a worthy successor to the old Stephenson Link Valve Gear, is written in a simple, practical manner, especially adapting it for the use of the locomotive engineer, the shop man and the master mechanic alike. The author is an air-brake instructor and understands how to present the subject in a manner making it easily comprehensible to those lacking in technical training.

In the first division the book gives a history and analysis of the Walschaert Valve Gear, in which the general principles of the gear are described most fully, together with the details of its operation, as compared with the Stephenson gear. This is followed by a description of the special application of the Walschaert gear to numerous of the recently built American and foreign locomotives.

The second division is devoted to "Designing and Erecting the Walschaert Valve Gear." In this section are given rules for erecting the gear and for setting the valves, preceding a general description of the method of designing and "laying out" the gear. This is followed by some "general notes for adjusting Walschaert Gear," and also by a discussion of "Helmholtz's Modification" of the gear, in connection with which the author for the first and only time digresses into a short theoretical discussion, taking up the Helmholtz modified gear, in which the Reauleaux and Zeuner diagrams are made use of in a manner which might somewhat confuse and mystify many of the intended readers of the book.

The third division consists of a short chapter on the "Advantages of Walschaert Valve Gear" and arguments for its use as an improvement over the Stephenson Link Motion.

The concluding portion of the volume is a catechism of about sixty important questions and their corresponding answers, some of which bear upon the salient points brought out in the preceding description and analysis and some of which take up practical observations and directions as to methods of procedure for engineers in cases of breakdown on locomotives equipped with the Walschaert gear.

The book contains a convenient and very complete index and is embellished by numerous illustrations, together with small cardboard working models of the valves for use in connection with two large insert charts showing the position of various portions of the gear at nine different points of the driving wheels revolution.

The work is clear and explicit in the manner of handling the subject, and it should give any careful reader an excellent idea of the principles and application of the Walschaert Gear, together with much important relative information of practical value to the engineman and master mechanic.

LABOR AND CAPITAL.—A Letter to a Labor Friend. By Goldwin Smith, D. C. L. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5 × 7¾ ins.; pp. 88. 50 cts., net.

A series of interesting and suggestive reflections on questions pertaining to labor and capital by a well-known historian and political economist are here presented. A general idea of the mental attitude of the author may be gained from the concluding paragraph, which we quote as follows:

> It would seem, then, that there is something to be said for acquiescing, provisionally at least, in our industrial system, based as it is on the general relation between capital and labor, and trying to continue the improvement of that relation in a peaceful way, without class war and havoc. Progress, in a word, seems more hopeful than revolution. When the socialist ideal, perfect brotherhood, is realized, there will be social happiness compared with which the highest pleasure attainable in this world of inequality, strife, and self-interest would be mean; but all the attempts to rush into that state have proved failures, some of them much worse. It is conceivable, let us hope not unlikely, that all who contribute to progress may be destined in some way to share its ultimate fruits; but there is no leaping into the millennium.

*Consulting Engineer, 17 Battery Place, New York.

Public Baths.

PUBLIC BATHS AND WASH-HOUSES.—A Treatise on Their Planning, Design, Arrangement, and Fitting, Having Special Regard to the Acts Arranging for Their Provision. With Chapters on Turkish, Russian, and Other Special Baths, Public Laundries, Engineering, Heating, Water Supply, etc. By Alfred W. S. Cross, M. A., F. R. I. B. A. London, England: B. T. Batsford. Imported by Charles Scribner's Sons, New York. Cloth; 7¼ × 11 ins.; pp. 281; 135 illustrations, partly in the text. $7.50, net.

The need for public baths and wash-houses was recognized in England as early as 1846, when a lengthy parliamentary act was passed authorizing their construction by municipalities. A large number of such establishments are now in use in England, and a goodly number, minus the wash-house feature, are to be found in the United States. Considering the number and size of our cities, however, we have done but little as yet to meet this growing need of closely built cities. Books on public baths are so few as to render any fairly creditable production on that topic welcome. The volume before us is a commendable one, particularly for its large number of illustrations of baths, wash-houses, and some of the fixtures required for each.

After an introductory chapter, in which the author pleads for more durable, monumental and artistic buildings to house public baths, the site and general arrangement of the various departments of a combined public baths and wash-house is considered and then swimming-baths are taken up in some detail, not overlooking the use of asphalt to make the latter water-tight. A chapter on slipper (tub) and on shower baths follows, after which the wash-house and then the "establishment laundry," or laundry for the bath house itself, are discussed and illustrated. Then follow chapters on the water supply, power and pumping plant, hot water and steam services, general heating and ventilation system, and the lighting of the building. These chapters consist largely of extracts from specifications. A section on "Administration and Cost of Maintenance" is contributed by Mr. E. J. Wakeling, chairman of the Baths and Wash-houses Committee of the Shoreditch (London) Borough Council. This chapter contains many practical suggestions. A few pages on exhaust steam heating are followed by some nine pages on "Turkish, Russian and Other Special Baths," and by three pages headed "Some Notes on the Cost of Construction." The last-named chapter will be disappointing to anyone who expects to find specific figures of cost. Appendixes give the Public Baths and Wash-Houses Act of 1846, already mentioned, and the various acts of amendment.

The author is an architect and the book is conceived and executed from the viewpoint of the architect rather than from that of the municipal official or the sanitarian. Drawings of a number of public baths designed by the author are included, but not to the exclusion of the work of other architects. The book would have been increased in value by giving more attention to other countries than England, particularly Germany and the United States.

COSTS OF HAULING CROPS FROM FARMS TO SHIPPING POINTS.—By Frank Andrews, Expert in Transportation, Division of Foreign Markets. Bulletin No. 49, Bureau of Statistics. Victor H. Olmsted, Chief of Bureau. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 63; numerous tables.

Returns are here presented from 1,894 counties scattered over the United States, regarding the cost of hauling 23 different farm products to shipping points. After a general discussion of the purpose and scope of the investigation and the methods employed, a summary table is presented, showing for the 23 products the number of counties reporting, average miles to shipping point, average days for round trip, average pounds in one load, and average cost per load per 100 lbs., per ton mile. The same detailed information is then given for each one of the 23 products by States and by five main geographical divisions. Following the tables are notes on methods of hauling and allied subjects.

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In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

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The Principles of Mechanism.

Reviewed by AMASA TROWBRIDGE,* M. Am. Soc. M. E.

THE PRINCIPLES OF MECHANISM.—Being a Short Treatise on the Kinematics and Dynamics of Machines. By Herbert A. Garratt, Assoc. M. Inst. C. E., Head of the Engineering Department of the Northern Polytechnic Institute, Holloway. London, England: Edwin Arnold. New York: Longmans, Green & Co. Cloth; 4¾ × 7½ ins.; pp. 166; 162 illustrations in the text. $1.10.

The author calls this book a "skeleton," and it bears out its name. It is a book for students who are under the guidance of an instructor, rather than a complete treatise for general use. It is divided into two general parts, Kinematics of Machines and Dynamics of Machines. In the former the principles of the forms of mechanisms are considered, no attention being given to the efficiencies of such mechanisms, to the masses moved or to the forces exerted. In the latter part, the dynamics of certain simple mechanical motions are considered. The treatment of the subject is better in the second part than in the first, but would be vastly improved by the use of numerical examples to illustrate the principles involved.

The treatment of water motors, which is given in part two of the book, seems rather out of place in a volume covering such a restricted portion of the subject of mechanisms. The space might have well been devoted to the treatment of quick-return motions, which subject has been entirely omitted. There is not enough of the hydromechanics to be of much value, so that the book would not have suffered by the omission of the matter on water motors.

For class-room work, as a text to be supplemented by extensive lectures, the book has a use, but it is not complete enough for the general student. Too much has been left out for the purpose of affording "a clear preception of the anatomy of the skeleton."

Plumbing Illustrated and Described.

MODERN PLUMBING ILLUSTRATED.—A Comprehensive and Thoroughly Practical Work on the Modern and Most Approved Methods of Plumbing Construction. The Standard Work for Plumbers, Architects, Builders, Property Owners, and for Boards of Health and Plumbing Examiners. By R. M. Starbuck, Author of "Questions and Answers on the Practice and Theory of Sanitary Plumbing." New York: The Norman W. Henley Publishing Co. Cloth; 7¼ × 10½ ins.; pp. 392; 55 plates. $4.

This unique and useful volume has been developed from sets of blue-prints, only, made by the author and put upon the market some years ago. A considerable amount of text now accompanies the illustrations, which latter appear as plates. The author takes up in succession kitchen sinks, laundry tubs, lavatories, and almost innumerable other plumbing fixtures, large and small, including various forms of traps, venting systems and the like. Two sections deal with the rough and the final testing of plumbing, respectively. The plumbing of cottages, more pretentious residences, flat and apartment houses, office buildings, bath-houses, engine-houses, stables, etc., is taken up. There are sections on the Durham system of piping, on construction without the use of lead, on thawing underground pipes by electricity, on the water supply and plumbing and sewage disposal of country houses, on boilers and hot water tanks. Besides the many subjects already mentioned, attention is given to pneumatic systems of water supply for affording pressure in isolated houses, hydraulic rams, windmills and the like. Cesspools, the septic tank, and the underground disposal of partly purified sewage are also considered, and a few paragraphs are devoted to domestic water filters. Exception must be taken to some of the author's remarks on water and sewage treatment, particularly his laying so much stress upon the use of animal charcoal for filters; his statement that the main action of water filters is bacterial, and therefore that an air supply in the filtering material is essential; his misconception of the purpose of a grit chamber associated with the septic tank; his idea that in moist ground, where subsoil irrigation would be impracticable, reliance could be placed upon "filter beds placed underground"; and finally, his suggestion that even for cities and towns the so-called bacterial methods of sewage treatment can be operated without cost. These exceptions, however, affect only a small part of the book, and probably most of them will do little harm, considering the class of readers concerned. The main purpose of the book seems to be admirably fulfilled, which is to show clearly, by drawings and text, what constitutes substantial and safe plumbing practice that shall at the same time be reasonably simple. Greater simplicity would be suggested, however, if the author were somewhat less conservative regarding the back venting of traps. This practice, when carried to an extreme, adds very materially to the cost of plumbing installation (the author places the increase at one-third), and, in the light of our present knowledge of the chemical and bacterial constituents of sewer air in a well-designed plumbing system, it seems unwarranted. The author appreciates the complication and expense entailed by back venting, as ordinarily practiced, and devotes considerable space to an exposition of the system of "continuous venting," which simplifies the venting problem not a little.

*811 St. Nicholas Ave., New York City.

HENLEY'S TWENTIETH CENTURY BOOK OF RECIPES, FORMULAS AND PROCESSES.—Containing Nearly Ten Thousand Selected Scientific, Chemical, Technical and Household Recipes, Formulas and Processes for Use in the Laboratory, the Office, the Workshop and in the Home. Edited by Gardner D. Hiscox, M. E., Author of "Mechanical Movements, Powers and Devices," etc. New York: The Norman W. Henley Publishing Co. Cloth; 6 × 9¼ ins.; pp. 787; illustrated. $3.

As a ready handbook for various processes and recipes which are often needed by everyone—such information, for instance, as the formula for photographic developer, the composition of the various paint-pigments, the manufacture of glue or of solder, or the thousand and one detailed bits of information which come up, as the title reads "in the laboratory, the office, the workshop and in the home"—such a book as this is very useful. But it seems rather out of its province to endeavor to give in so short a space as can be allowed to any one article any account of the larger materials of engineering. The recent failures in reinforced concrete may have been induced by a too strict adherence to the following, which is found under the heading, "Concrete":

> For beams and lintels a light aggregate such as coke breeze from gas works is permissible. Especially when the work is designed to receive nails. . . . It [Portland cement] should not be used in too hot a condition, to which end it is usually spread on a wooden floor to a depth of a few inches, a few days prior to use.

RIVETAGE.—By M. Fricker. From "Encyclopédie Scientifique des Aide-Mémoire," published under the direction of M. Léauté. Paris, France: Gauthier-Villars. Paper; 4¾ × 7½ ins.; pp. 168; 40 illustrations in the text.

The subject of riveting has been thoroughly treated in English in monographs, articles in the technical press and in chapters in books on the general subject of steel work, but never on so extensive a scale as in this French work. The book is divided into two parts. In the first part the various uses of rivets and the different kinds of riveted joints are treated, followed by a discussion of the characteristic elements of riveting such as the shapes and proportions of rivets and their spacing. The author then gives the various analytic and graphic theories of computations, with numerous applications to various cases. The second part describes in detail the operation of riveting, including the manufacture of material, the making of rivets, the machinery used in placing them and rules for their inspection.

THE PEABODY ATLAS.—Shipping Mines and Coal Railroads in the Central Commercial District of the United States. Accompanied by Chemical, Geological, and Engineering Data. By A. Bement. Chicago, Ill.: Peabody Coal Co. Cloth; 16¾ × 18½ ins.; pp. 149; numerous illustrations. $5.

The conditions in the coal-carrying railways and their relations to the coal mines play an important part in the administration of the finances of the railways which is just now the subject of so much political and economic importance. To the investigator in this field, the statistics of the various bituminous mines and contributing railways throughout the Central States, which is given in this atlas, should be of as great value as they also are to the various dealers for whom the book will serve the purpose of a trade directory. In addition, the atlas contains some valuable information and illustrations on smokeless furnaces and smoke prevention, analysis of combustion gases and improvements in boiler designs.

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RAILWAY SIGNAL ASSOCIATION.—Proceedings for the Year 1906. Bethlehem, Pa.: The Association (C. C. Rosenberg, Secy., 12 Linden St.). Paper; 6 × 9 ins.; pp. 342; folding and other plates and text illustrations.

This volume contains the proceedings of the several meetings held during 1906, including discussions of track circuits in the New York subway, interlocking and block signals, effect of foreign currents upon automatic block signals, and keeping railway switches free from snow and ice. There are also specifications for line and signal wire, mechanical and electrical interlocking, etc. The subject matter is of value, but the arrangement of the book is defective, papers and discussions on the same subject being found at different places, and the constitution and by-laws being at the middle of the book. This is due to arranging the matter chronologically, and detracts from the usefulness of the book. The index is little more than a list of contents.

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Rocks and Soils.

A TREATISE ON ROCKS, ROCK-WEATHERING AND SOILS.—By George P. Merrill, Head Curator of Geology in the U. S. National Museum, and Professor of Geology in the George Washington University, Washington, D. C.; Author of "Stones for Building and Decoration," "The Non-Metallic Minerals," "Contributions to a History of American Geology," etc. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5¾ × 8¾ ins.; pp. 400; 31 plates and 42 text illustrations. $4, net.

SOILS—Their Formation, Properties, Composition, and Relations to Climate and Plant Growth in the Humid and Arid Regions. By E. W. Hilgard, Ph. D., LL. D., Professor of Agriculture in the University of California, and Director of the California Agricultural Experiment Station. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 6 × 9 ins.; pp. XXVII. + 593; 89 illustrations in the text. $4, net.

By chance these two books, closely related in subject-matter, but wholly independent in origin, appeared about the same time. They overlap to a slight extent, only, "Rocks" being essentially a treatise on the weathering of rocks, with special reference to the formation of soil, and "Soils" being considered almost wholly in their relation to agriculture. Each volume contains matter of interest and value to engineers, "Rocks" leading in this respect—except that to some irrigation engineers "Soils" might be most serviceable. Each volume was written by an authority in his chosen field, and each is notable for the wideness of its geographic range. Professor Hilgard's book, as its full title indicates, covers soils in both humid and arid regions.

Professor Merrill leads up to his main subject by describing briefly the chemical elements, the mineral constituents, the physical and chemical properties, and the mode of occurrence of rocks. Double the space is then devoted to a detailed classification and description of various kinds of rocks, under the main heads of igneous, aqueous, aeolian and metamorphic rocks. Thus far, 150 pages have been filled. About 125 pages are then given up to rock-weathering. General principles are first considered, including the action of the atmosphere (various acids, oxygen, heat and cold, and wind), the chemical action of water, the mechanical action of both water and ice, and finally the action of plants and animals. The weathering of special forms of rock, such as granite, syenite and basalt, is then discussed, after which the manifestations of weathering, as influenced by rock structure, position, exposure, etc., are taken up. Rates of weathering, as influenced by texture, humidity, climate and altitude, are next reviewed. A brief section on the transportation of rock debris, by gravity, water, ice and wind, is full of interest. The concluding hundred pages deals with "The Regolith," or blanket of "superficial and unconsolidated" disintegrated stone that has been formed during "the millions of years which have elapsed since the earth assumed its present form and essentially solid condition." This closing part deals in succession with sedentary and transported materials and with "The Soil." To the latter topic about 40 pages are given, dealing with the chemical nature, mineral composition, physical condition, weight, color and age of soils, and finally the effects of plant and animal life.

The foregoing outline will serve to give a general idea of the plan and scope of Professor Merrill's book, which combines a large amount of matter of a purely categorical and descriptive scientific character with an almost equally large amount of matter of interest and value to any wide-awake person wishing to know about the earth on which he lives. In addition, the book is, as already intimated, of great possible service to the many engineers.

Professor Hilgard's book, in broad outline, deals with the origin and formation, the physics and the chemistry, of soils, and with native vegetation as an aid to the study of the agricultural value of soils. The section of most value to engineers as a class is the one on the "Physics of Soils." This deals with such topics as density, pore-space, volume-weight, hygroscopic and capillary moisture, surface, hydrostatic and ground water, evaporation, the conservation or regulation of soil moisture (including a number of pages on irrigation), and the air and the color of soils. In addition, consideration is given to the soils and subsoils and to humus.

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A chapter on the relation of soils to sewage treatment, and particularly to sewage farming, would not have been out of place in this section and might have been made very helpful to engineers. Crude data bearing on the subject are given, but, naturally enough, without correlation to the subject of sewage treatment.

The section on "Chemistry of Soils" treats of physical and chemical analyses, and discusses at some length the soils of both the humid and the arid regions. A whole chapter is given to alkali soils and another to the "Utilization and Reclamation of Alkali Lands," both of which cannot fail to be of great value to large sections of our western country.

The closing section of three chapters, on "Soils and Native Vegetation," might prove helpful to engineers called on to value lands. In these chapters the author develops in some detail the principle often expressed throughout the whole book, that the character of soils can be recognized from their native vegetation, and particularly their trees. Diagrams and photographs are employed to elucidate this principle, which the author has put in practice during his half century of experience throughout a large part of the United States.

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.—Proceedings, Vol. XXXII., 1905-1906. Edited by Thomas Cole, Assoc. M. Inst. C. E., Secretary of the Association. London, England: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 5½ × 8¾ ins.; pp. lxiv. + 470; folding and other plates.

It is the practice of the association named above to hold some six or eight "district meetings" and one general meeting each year. At the district meetings there is generally presented a review of the municipal work of the town or city in which the meeting is held, and also one or more papers on the local water-works, sewerage or lighting systems. During the year covered by this report, meetings were held at Swansea, Berwick-upon-Tweed, Battersea and other places. The Battersea meeting was addressed by Hon. John Burns, M. P., President of the Local Government Board. Included in the Proceedings of the annual meeting are papers by W. J. Dibdin, on Primary Contact Beds; J. D. Watson, on Sewage Disposal, and J. D. Brodie, on Motor Traction. The mechanical execution of the volume is commendable and its contents are interesting.

STATE WATER SUPPLY COMMISSION OF NEW YORK.—Annual Report for Year Ending Feb. 1, 1907. (Henry H. Persons, President.) Albany, N. Y.: Pub. Doc. Cloth; 5¾ × 9 ins.; pp. 331.

Besides reviewing applications for the approval of water supply plans made to the Commission during the year, this report contains a number of suggestions regarding protection of purity of public water supplies, flood prevention and water power. It also contains tables of statistics of the municipal water supplies of the State and more detailed reports, in the form of text, describing practically all the water-works in the State not previously described in the first report of the Commission.

STATE BOARD OF HEALTH OF THE STATE OF OHIO.—Annual Report for the Year Ending Dec. 31, 1905. (C. O. Probst, M. D., Secy.) Springfield, Ohio: Pub. Doc. Cloth; 6½ × 9¾ ins.; pp. 501.

Besides an account of the routine work of the Board, brief reports from local boards of health, and a summary of mortality reports of the State, this volume contains a large number of reports on applications for the approval of plans for water supply and sewerage systems, including in both instances purification works.

THE DECOMPOSITION OF THE FELDSPARS.—By Allerton S. Cushman, Assistant Director, Office of Public Roads, and Prevost Hubbard, Assistant Chemist, Office of Public Roads. Bulletin No. 28, Office of Public Roads. Logan Waller Page, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 29; six illustrations in the text.

This interesting chemical and physical study of the decomposition of feldspars is a continuation of previous investigations conducted with the idea of throwing light upon "the binding power of rock dust" as applied to the construction of macadam roads.

BULLETINS OF THE ENGINEERING EXPERIMENT STATION, UNIVERSITY OF ILLINOIS.—Vol. I. (Bulletins 1—8, Circulars 1—2.) September, 1904—September, 1906. Urbana, Ill.: The University. Half leather; 6 × 9¼ ins.; plates, text illustrations and tables. For special distribution.

Most if not all the bulletins included in this handsome volume have been noted in earlier issues of this Supplement. Some comments on a quotation from one of the bulletins and on the experiment station that issues them may be found in the editorial pages of the main portion of this issue of Engineering News.

RAPID TRANSIT IN AND ABOUT NEW YORK CITY.—By a Committee on City Plan, Calvin Tomkins, Chairman. New York: The Municipal Art Society (119 East 19th St.). Cloth; 5½ × 8¾ ins.; pp. 188; folding plates and text figures.

This volume brings together under one binding a number of separate reports, some of which have not previously been distributed, on various phases of the subject of rapid transit in New York and vicinity.

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City Improvement Plans.

A CITY PLAN FOR ST. LOUIS.—Reports of the Several Committees Appointed by the Executive Board of the Civic League to Draft a City Plan. St. Louis, Mo.: The Civic League (Mr. Mayo Fesler, Secy.). Paper; 7¼ × 10¾ ins.; pp. 113; folding and other plates and text illustrations.

It is a pity that our American cities did not begin many decades earlier to consider the need of having well-formulated city plans for guidance in their development. Within the last five years the subject has been taken up in a considerable number of cities and towns, either by the city itself or by some organization or group of organizations interested in the welfare of the city. The handsome report now before us is the result of the action in November, 1905, of the Executive Board of the Civic League of St. Louis. The board at that time appointed a committee of five members, on "the feasibility and scope of a comprehensive city plan." Subsequently five other committees were appointed to submit reports on various phases of the subject in hand, and a general committee was also created "to coordinate the recommendations of the several committees." Besides the report of the general committee, the volume before us includes reports on a group plan for municipal buildings; an inner and outer park system; minor civic centers; street improvements; a municipal art commission; and legislation. Each of these subjects is treated in some detail and the points made are reinforced by both text and illustrations showing what has been done or attempted along the various lines elsewhere. A number of maps, some on a fairly large scale, are included.

BOSTON SOCIETY OF ARCHITECTS' REPORT OF COMMITTEE ON MUNICIPAL IMPROVEMENTS.—(Robert S. Peabody, Chairman; Irving T. Guild, Secretary.) Boston, Mass.: The Society. Paper; 9 × 12 ins.; pp. 29; numerous plates.

Almost simultaneously with the St. Louis report noted above, appeared one by a committee of the Boston Society of Architects, on plans for "making Boston, now and as it grows larger, more convenient for its inhabitants, better adapted for commerce, and more beautiful in appearance." Aside from its subject matter, this Boston report is notable in that it was printed at the joint expense of the society already named and the following additional Boston organizations: Boston Chamber of Commerce, Boston Real Estate Exchange, Metropolitan Improvement League, Boston Stock Exchange, Boston Merchants' Association, Boston Board of Fire Underwriters, and Master Builders' Association of Boston. All the bodies sharing the expense wish it understood that the report is one of suggestion, only issued "in the hope that it may lead to fuller investigation by competent authorities."

After a general report in which improvements to the city plan of a number of American and foreign cities are discussed, the report makes suggestions for inner and outer boulevards, development of the Charles River basin, improvement of Copley Square and Dorchester Heights, extensions and widening of a number of streets, establishment of communications by inland waterways, and improvement of the port of Boston. Photographs and diagrams are freely used to illustrate what is said regarding both foreign cities and the improvements suggested for Boston.

Publications Received.

THE ANATOMY OF BRIDGE WORK.—By William Henry Thorpe, Assoc. M. Inst. C. E. London, England: E. & F. N. Spon., Ltd. New York: Spon & Chamberlain. Cloth; 4½ × 7½ ins.; pp. 190; 103 illustrations in the text. $2.50.

THE CHEMISTRY AND TECHNOLOGY OF MIXED PAINTS.—By Maximilian Toch, Director of the Laboratory of Toch Brothers, New York City. New York: D. Van Nostrand Co. Cloth; 6 × 9½ ins.; pp. xvi. + 166; plates and text illustrations. $3, net.

ENGLISH WEIGHTS WITH THEIR EQUIVALENTS IN KILOGRAMS.—Calculated from 1 Pound to 1 Ton by Pounds and from 1 Ton to 100 Tons by Tons. Compiled expressly for the use of Merchants and Shipping Agents, to facilitate the making out of documents as required by Foreign Customs Authorities. By Frederick W. A. Logan. London, England: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Flexible cloth; 4 × 3¼ ins.; pp. 89. 50 cts.

EXTRACTS FROM REPORTS UPON TECHNICAL DETAILS OF ENGINEERING WORKS, 1906.—No. 23, Occasional Papers, Engineer School, U. S. A. Washington Barracks, D. C.: Pub. Doc. Paper; 6 × 9 ins.; pp. 18; folding plates.

FOREIGN LAWS RELATING TO RAILWAY EMPLOYEES.—In Bulletin of the Bureau of Labor No. 68, January, 1907. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 116 to 243.

HANDBOOK OF METALLURGY.—By Dr. Carl Schnabel, Königl. Preuss. Ober-Bergrath Professor of Metallurgy. Translated by Henry Louis, M. A., A. R. S. M., F. I. C., etc., Professor of Mining at Armstrong College, Newcastle-upon-Tyne. Second Edition. Vol. II. Zinc — Cadmium — Mercury — Bismuth — Tin — Antimony — Arsenic — Nickel — Cobalt — Platinum — Aluminum. London, England: Macmillan & Co., Ltd. New York: The Macmillan Co. Cloth 6 × 9 ins.; pp. 867; 532 illustrations in the text. $6.50.

JOURNAL OF THE IRON AND STEEL INSTITUTE.—Vols. LXXI. and LXXII.; Nos. III. and IV., 1906). Edited by Bennett H. Brough, Secretary. London, England: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 5½ × 8¾ ins.; pp. 1,015; numerous tables and text illustrations and 55 plates. $6 each.

LONG-DISTANCE ELECTRIC POWER TRANSMISSION.—Being a Treatise on the Hydro-Electric Generation of Energy; Its Transformation, Transmission, and Distribution. By Rollin W. Hutchinson, Jr., Assoc. M. Am. Inst. E. E. New York: D. Van Nostrand Co. Cloth; 5 × 7¾ ins.; pp. 345; 136 illustrations in the text. $3, net.

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